

APRIL 7, 1981

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The planetary alignment that began March 25 and evolved through April 7 placed Saturn, Jupiter, Earth, The sun, Venus, and Mars in a rough line, a configuration properly called 'zygy.' About a year later, they will come into a much rougher conjunction on the same side of the sun. But, according to McInosh, this month's zygys places the planets much closer to a common line, and would be the most favorable configuration for the so-called Jupiter Effect to be felt.—PMB

Voyager Status Report

As the Voyager 1 spacecraft speeds away from Saturn, it leaves in its wake a plethora of data for the team scientists to puzzle over. Although they still grapple with data from the November 12 encounter, the team scientists have put together a report of their early findings. This report, published in the April 10 issue of *Science*, was recently summarized at NASA headquarters by representatives of the Voyager team.

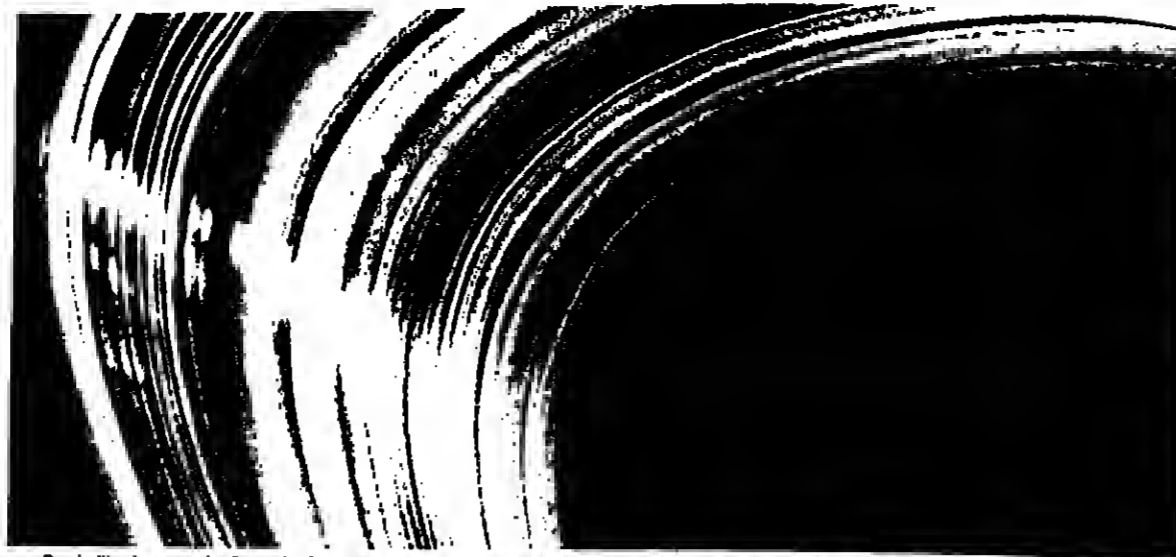
The analyzed data confirm some earlier hypotheses (*Eos*, Dec. 2, 1980, p. 1201) and necessitate reshaping of others. For example, the 'epokes' in the B ring are probably explained by Keplerian laws, or so it was hypothesized immediately after the Saturn flyby; magnetic forces also may be affecting the ring. But Titan was found not to be the largest satellite in the solar system.

Saturn's rings, though complex, do not contain known laws of physics, explained Bradford Smith, Voyager imaging team leader. The problem, however, is in applying the known laws. The apparent 'breeding' of strands in the outermost F ring remains a mystery, as does the mechanism by which the myriad rings and ringlets remain discrete. The satellite resonance theory proposed by Peter Goldreich of JPL and Scott Tremaine at Princeton University seems to hold true for many of the known satellites. However, the C ring's regularly spaced ringlets show no clear association with satellite resonances, Smith added.

Titan's atmospheric haze previously prevented accurate measurement of the satellite's size. Edward C. Stone, Voyager project scientist, reports that Titan's radius is 2570 km, about the distance between Dallas and Boston. The temperature of Titan's surface is 93° K; the pressure is 1.8 atmospheres. Stone said. Methane's triple point—the temperature at which it can exist as a solid, liquid, and gas—is 91° K. Therefore, if the atmosphere contained 5% methane, Stone explained, a methane ice cloud would form 5–10 km above Titan's surface. The amount of methane in Titan's atmosphere is uncertain, however.

Smith reported that the barely visible brightness difference between Titan's northern and southern hemispheres may be related to the effects of the solstice. Titan shows a phase lag of 90° or one-quarter of a year, Smith explained. Therefore, at the equinox the effects of the solstice would be visible. Titan is just entering equinox now.

Heavy cratering on many of Saturn's satellites may be



Spoke-like features in Saturn's rings are seen as bright areas in this image taken by Voyager 1 on November 13, 1980, when the spacecraft was 938,000 km from the planet's cloud tops. Where sunlight lower-angles on the rings, the spokes appear bright; the same features appear dark in backscattered light. In this view, the concentric structure in the B ring increases contrast and accentuates hundreds of light and dark ringlets. (Photo courtesy of NASA).

the result of two bombardment periods, the scientists believe. Most of the large craters (20 to 100 km) were formed during the first period, according to the hypothesis.

Smoothing of the surfaces of the larger satellites was accomplished with tectonic activity, perhaps driven by radioactive decay. The second bombardment period produced smaller craters. Material spewed into the Saturnian system during the first bombardment may have been responsible for the second 'bombing.' One problem with this model, Smith said, is that scientists are unsure what the driving force was that smoothed Tethys' surface, since the satellite is el-

most entirely ice. Another problem is explaining the unblemished complexion of Enceladus.

Soon Voyager 1's sister craft, Voyager 2, will take the spotlight. Scheduled for its Saturn encounter on August 25, Voyager 2 will attempt to fill in gaps of information left by Voyager 1. Specifically, the craft will take a closer look at Enceladus, the satellite Hyperion, and the complex ring system. JPL's Davis expects the programing of the spacecraft sequence to be completed by late May or early June. He gave both craft a clean bill of health: 'Things are going according to plan.'—BTR

IIASA Energy Study Unveiled

Meeting the energy needs of the world in 2030, when the projected population will be 8 billion, can be done, but not without international cooperation, a mix of energy technologies, and an understanding of the dependence of resources and use. That's the optimistic conclusion of the 7-year global energy study by the International Institute for Applied Systems Analysis (IIASA).

Results of the international study were published last month in two volumes. *Energy in a Finite World: Paths to a Sustainable Future* outlines the strategies IIASA believes will meet energy needs; its companion volume *Energy in a Finite World: A Global Systems Analysis* presents the study's complete technical findings.

According to Wolf Häfele, leader of the Energy Systems Program Group, IIASA's conclusions are similar to those reached by the 4-year study done by the National Academy of Sciences' Committee on Nuclear and Alternative Energy Systems (CONAES) (*Eos*, Feb. 19, 1980, p. 90). However, the results differ in the types of transition periods to technology mixes. While CONAES envisions one transition period (1985–2010), IIASA sees two. The first will last through 2030, and the second transition will occur through the end of the 21st century.

Global Primary Energy by Source, Two Supply Scenarios, 1975–2030 (TWYr)^a

Primary Source ^a	Base Year 1975	High Scenario		Low Scenario	
		2000	2030	2000	2030
Oil	3.83	5.88	8.83	4.76	5.02
Gas	1.51	3.11	5.87	2.53	3.47
Coal	2.28	4.94	11.88	3.92	6.45
Light water reactor	0.12	1.70	3.21	1.27	1.89
Fast breeder reactor	0	0.04	4.88	0.02	3.28
Hydroelectricity	0.50	0.83	1.48	0.83	1.48
Solar ^c	0	0.10	0.49	0.09	0.30
Other ^d	0	0.22	0.81	0.17	0.52
Total ^e	8.21	18.84	35.65	13.69	22.36

^aTwelve-year per year; 1 TWYr = 30×10^{18} BTU.
^bPrimary fuel production or primary fuels as inputs to conversion or refining processes—for example, cost used to make synthetic liquid fuel is counted in coal figures.
^cIncludes mostly 'soft' solar—individual rooftop collectors—and also small amounts of centralized solar electricity.
^d'Other' includes biomass, geothermal, and commercial wood use.
^eColumns may not sum to totals because of rounding.
Source: *Energy in a Finite World: Paths to a Sustainable Future*

During the first period, the globe will continue to consume fossil fuels, but the fuel will become increasingly dirty. The major transition to renewables—solar, geothermal, ocean currents, wind power, hydropower, etc.—will come late in the next century, according to the IIASA report.

The study engaged the help of 140 scientists from 20 countries, a first for this type of study. IIASA stresses the global nature of the energy problem: 'While the problem suits only selectively... But such provincialism can only lead to dangerously misguided national policies,' the report states. Following this reasoning, IIASA included all countries in the analysis, but grouped them into seven regions categorized by natural energy resources and economic structure. Geographic proximity was not necessarily a consideration. For example, one region encompasses Western Europe, Australia, Israel, Japan, New Zealand, and South Africa. These have developed market economies, but are poorer in resources than other developed regions.

The initial, 50-year transition was chosen for four reasons that allow for technological and social change. First, by the year 2030, IIASA estimates that the world population will double from its present 4 billion—the steepest increase ever. Second, 50 years is approximately two complete life cycles for power plants and energy facilities. Third, the time period represents two human generations and the accompanying social changes. Last, the time frame allows for market penetration of advanced energy technologies. To expect a transition to a sustainable worldwide energy system within anything much less than 50 years would be to flagrantly ignore history,' according to IIASA.

Increasingly dirty fossil fuels will be used through the first transition period, the IIASA report said. Global dependence on synthetic fuels and unconventional oils will increase through 2030. Approximately 80% of the energy supplied 2030 will be from dirty fossil fuels, Häfele said. 'There is no way of partly escaping the dirty route,' he added. The report states that sometime around 2000, large-scale coal liquefaction will become necessary, although Häfele could not define the process most likely to be used. Joining liquefaction in 2000 will be fast-breeder reactors, in IIASA's picture.

Two Benchmark Scenarios

IIASA developed two benchmark scenarios based on the level of worldwide energy demand—'high' and 'low.' As illustrated in the accompanying table, the high scenario relies mostly on coal-fueled energy in 2030, while the low scenario relies almost equally on oil as on coal. Magnetic hydrodynamics and fusion energy will not significantly contribute to global energy by 2030.

Three alternative cases also were presented: a nuclear moratorium case, an enhanced nuclear case, and zero-per-capita growth rate. In the last, global energy use is restricted to the present rate and requires extreme conservation measures.

Given the world situation and the history of noncooperation among nations, is the optimism expressed in the report justified? Although Häfele said he agrees with the bottom line of the report—that energy needs can be met with world resources—he is less optimistic about the needs being met. He pointed to an increasing dichotomy between the perception of reality and reality itself. The political situation, economics, and the cold war could block the securing of energy to meet global demands.—BTR

Petroleum Data Available

New geological and geophysical data associated with certain regions in the National Petroleum Reserve in Alaska (NPRA) are available to the public from the National Geophysical and Solar-Terrestrial Data Center.

These data were collected and processed by several companies under contract to the U. S. Geological Survey. Purpose of the data collection was to evaluate the petroleum potential of portions of the NPRA.

Included in the available data are seismic data, well logs, and gravity data through September 30, 1980.

Inquiries on the files listed below should be addressed to National Geophysical and Solar-Terrestrial Data Center, NOAA/EDIS (D82), 325 Broadway, Boulder, CO 80303 (telephone: 303/497-8826).

File Number	Subject
1981 (SE-E) NPRA 10 Well Logs and Auxiliary Data (1978–1980)	
1981 (SE-D) NPRA Seismic Data (FY 1980)	
1980 (SE-NN) NPRA Gravity Data (1974–1980)	
1980 (SE-MM) NPRA Geological Data (FY 1978)	
1980 (SE-LL) NPRA Seismic Data (FY 1978)	
1980 (SE-HH) NPRA Common Depth Point (CDP) Field Tapes	

NRC Associateship Survey

The National Research Council (NRC) wants to locate its former research associates and visiting scientists research associates to verify official records. The NRC also hopes to assess the effects of the research associateship programs on career development.

All associates should send their correct mailing address, dates of tenure, and the name of the laboratory where the associateship was pursued to F. A. Crump, Assistant to the Director of Associateships, National Research Council, 2101 Constitution Avenue, Washington, D.C. 20418.

Geophysicists

John S. Dickey, Jr., has been appointed chairman of the geology department and Jessie Page Heroy Professor of Geology at Syracuse University. He will leave his post as director of the petrology/geochemistry program in the Division of Earth Sciences at the National Science Foundation to begin his duties at the university on July 1.

Classified

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Planetary Geologist. Tenure track assistant to associate professor position starting September 1, 1981, or as soon as possible thereafter to teach and conduct research in planetary geologic processes on Earth and other planets. Research focus is on understanding the physical processes (for example, impact cratering, volcanism, tectonics, etc.) responsible for the origin of planetary surfaces. Applicants must have Ph.D. in planetary geophysics or geology. Deadlines for applications is June 15, 1981. Inquiries to: Paul C. Hess, Chairperson, Department of Geological Sciences, Brown University, Providence, RI 02912. An equal opportunity and affirmative action employer.

Faculty Opening. The Department of Geological Sciences of the State University of New York at Albany invites applications for a tenure track faculty position which will be available from September 1, 1981 at the assistant professor level for a research strengths in structural geology, tectonics, geomorphology, geophysics and geochemistry with M.S. degrees who are qualified to complement or expand existing faculty. Salary will be negotiable. Letters should be addressed to: Professor Science, 50 Personnel Department, State University of New York at Albany, Albany, N.Y. 12222. An equal opportunity and affirmative action employer. Applications from women, minorities and handicapped are especially welcome.

New Publications

China Science and Technology Abstracts

International Science and Technology Information Service, Hong Kong, \$5.00 per issue.

Reviewed by Carl Kisslinger

The obvious purpose of a review of a new abstract journal is to bring it to the attention of potential users and offer some idea of the scope of the contents. I was sent Volume 1, Number 2, October 1980, and, if it is typical, the publication will be of definite value to many readers of *Eos*. The stated purpose of the journal is 'to give them (i.e., scientists outside of China who cannot read the Chinese language) an outline of the latest development of science and technology in China.' From the sample I examined, the journal achieves this purpose admirably. Sixty-nine 'highly reputed Chinese periodicals' provided the material for the particular issue. The claim that each issue will contain about 500 abstracts seems exaggerated, since many of the entries are titles only. However, even these serve to give a feeling for the main lines of current research interests, and many of the real abstracts are sufficiently long and detailed to be useful as sources on research results (though without the supporting data).

The abstracts are classified under major disciplinary headings, with appropriate subheadings; mathematics, astronomy, physics, chemistry, earth science, engineering, physics, mechanical engineering, electrical and electronic engineering, architecture and civil engineering, transportation engineering, technology of industrial chemicals, and other branches of engineering. The classification of the papers under these headings is fairly arbitrary. Material of interest to various sections of AGU is scattered throughout, but most relevant material is naturally found under astronomy, physics, and earth science (an entry on acupuncture signals in cerebral cortex under 'astronomy' is a rather startling slip). The earth science section is further divided by topics ranging from geodesy and geophysics, through geodynamics (internal and external), to oceanography, hy-

drography, meteorology, petrology and geochemistry, and economic geology.

China Science and Technology Abstracts is especially attractive as an information source because the publisher offers copies of the original articles (\$0.50 per page), English translations (\$10 per 100 English words), and extended English abstracts (roughly one-tenth the original length, at \$15 per 100 English words). The quality of the English language in the abstracts I read is quite good so that one can be optimistic that the translations offered will be satisfactory with regard to readability.

Carl Kisslinger is with the Cooperative Institute for Research in Environmental Sciences, University of Colorado at Boulder, Boulder, Colorado.

New Listings

Items listed in New Publications can be ordered directly from the publisher; they are not available through AGU.

Advanced Chemical Methods for Soil and Clay Minerals Research, J. W. Stuck, W. L. Banwart (Eds.), D. Reidel, Hingham, Mass., viii + 477 pp., 1980, \$58.00.

Archean Greenstone Belts, Developments in Precambrian Geology 3, K. C. Condie, Elsevier, New York, 434 pp., 1981, \$122.00.

A Climatologic and Oceanographic Analysis of the Georges Bank Region of the Outer Continental Shelf, Final Report to the Bureau of Land Management, U.S. Department of the Interior, U.S. Department of Commerce, NOAA, x + 290 pp., 1980.

The Primordial Bond: Exploring Connections Between Man and Nature Through the Humanities and Sciences, S. H. Schneider and L. Morton, Plenum, New York, xii + 324 pp., 1981, \$15.95.

United States Earthquakes, 1978, C. W. Stover and C. A. von Hake (Eds.), U.S. Department of the Interior and U.S. Department of Commerce, Boulder, Colo. vii + 112 pp., 1980.



Rijksuniversiteit Utrecht

The subfaculty of Geology and Geophysics at the State University of Utrecht (the Netherlands) invites applicants for the position of

LECTURER

(wetenschappelijk (hoofd) medewerker) M/F.

In the workgroup Exploration Geophysics, which is a part of the Department of Geophysics of the Solid Earth.

Candidates should have experience for at least four years, shown by successful surveys or publications in at least one of the following fields:

1. electric (including electromagnetic) prospecting,
2. telluric or magnetotelluric investigations,
3. interpretation of electric and nuclear well logs, and
4. prospecting by the self potential and the induced polarization method.

The duties include teaching (in English or Dutch) of courses in electric prospecting methods and the supervision of practice and fieldwork. The lecturer is expected to conduct research in a field related to his experience, by preference in the field of physical and petrophysical foundations of well log interpretation or on the application of magnetotelluric methods to exploration problems.

It concerns a temporary appointment for four years with possibility for tenure after that period.

Salary, depending on age and experience to a maximum of 7286,—DFL.

Candidates are requested to submit their application, including a curriculum vitae and a list of publications within three weeks after publication to

Personnel Department
Institute of Earth Science Utrecht
Budepostaan 4
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The Netherlands, hr.145.001.

Geophysical Monograph 16
Flow and Fracture of Rocks (1980)
edited by H.C. Heard, I.Y. Borg,
N.L. Carter and C.B. Raleigh

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Three visible braiding 'strands', composing Saturn's F ring, are seen in this photo taken on November 12, 1980. The F ring is bounded by two 'shepherding' satellites discovered by Voyager 1. Scientists believe the gravitational effects of the two satellites may confine particles in the F ring to a narrow band. In addition, the braiding structure of the ring may be a result of the eccentric motion of the two small satellites. The A ring and the Encke Division are seen to the upper right. (Photo courtesy of NASA).

Director CIMAS UNIVERSITY OF MIAMI

The University of Miami is searching for a director of its Cooperative Institute for Marine and Atmospheric Studies. CIMAS was established in 1977 by the University of Miami and the Environmental Research Laboratories of the National Oceanic and Atmospheric Administration to serve as a focal point for comprehensive research on specific problems of the ocean and atmosphere.

Present research is concentrated in three areas:

1. Oceanic variability on climatic scales
2. Sediment Dynamics
3. Ecological Modelling

The director should have a national and international scientific reputation in one of these three research areas and take an active interest in each of them.

The successful candidate will also receive an appointment as professor in one of the scientific divisions of the Rosenstiel School of Marine and Atmospheric Science of the University of Miami.

The term of the director of CIMAS shall normally be five years and is renewable. Applications including a current professional resume and three references, and further information should be sent to Dr. Warren J. Wiebe, Chairman of the Search Committee for Director of CIMAS, University of Miami, Rosenstiel School of Marine and Atmospheric Science, 4600 Rickenbacker Causeway, Miami, Florida 33149. Nominations and applications desired by June 15, 1981. Position will remain open until filled.

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Structural Geology/University of Illinois at Chicago. The Geology Department is seeking a structural geologist for a tenure-track (assistant professor) faculty position. A Ph.D. is required. Salary open. The successful candidate will be expected to teach advanced undergraduate and graduate courses in structural geology and establish a research program. For equal consideration, applications, including the names of three references, should be sent to Dr. Robert C. Anderson, Department of Geology, University of Illinois at Chicago, 245 Natural History Building, 1301 West Green Street, Chicago, IL 60607. (312) 333-6713. Position to be filled by 1-1-82. The University of Illinois is an affirmative action equal opportunity employer.

Associate Professor/New Mexico State University. Geophysics at NMSU is an interdisciplinary program between the Department of Physics and the Department of Earth Sciences with an emphasis in exploration geophysics. We are seeking an additional tenure track faculty member with a background in other geophysics and seismology or electrical and electromagnetic methods. The successful candidate will be expected to teach upper division and graduate courses, conduct research, and to supervise graduate students' thesis and dissertation research in the candidate's area of expertise. The appointee will also be expected to teach freshman and sophomore level courses in other physics or geology. Minimum qualifications include an earned doctorate in geophysics or a closely related area and demonstrated research capabilities. Teaching experience and a proven ability to secure research funding are desirable but not essential. The expected salary range for this position is \$26,000-\$28,000 for the nine-month academic year.

Applications and letters from at least three references should be submitted by May 15, 1981 to either Dr. Russell E. Clements, Head, Department of Earth Sciences, Box 3AB or Dr. August Miller, Head, Department of Physics, Box 30, Las Cruces, NM 88003. New Mexico State University is an affirmative action equal opportunity employer.

Professor/Chemical Oceanography. The Department of Oceanography at Texas A&M University invites applications for an academic faculty position. The appointment is expected to be made at the level of professor.

Hence, applications are solicited from individuals who have demonstrated scholarship in research and teaching. Outstanding applicants suitable for appointment to academic ranks other than professor will also be considered, but preference will be given to applicants suitable for appointment to the higher ranks.

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Visiting Assistant Professor. One-year, temporary position available August 1981 to teach mineralogy, general geology, and perhaps optical mineralogy. The successful candidate will be required to teach three courses during a two-semester year; someone who enjoys teaching is needed. Persons on leave are encouraged to apply. Deadline for applications is April 17, 1981. Please send resume to David Kinsley, Department of Geology, Arizona State University, Tempe, AZ 85281.

ASU is an equal opportunity employer.

Petrology/Oceanography, University of New Brunswick. The Department of Geology has a tenure track position available from 1 July, 1981, at assistant professor or higher level. The successful applicant will be expected to teach both undergraduate and graduate as well as carrying out research and supervising graduate students. This position is in addition to one currently advertised for a rock mechanic or geochemist.

The applicant should have a background in petrochemistry and petrology and should be prepared to teach in some aspects of petrology and geochemistry. The successful applicant will be responsible for supervision of analytical facilities including an XRF.

Applicants should have a Ph.D. and, preferably, postdoctoral experience. Applications including a curriculum vitae and names of three references should be sent to P. F. Williams, Chairman, Department of Geology, University of New Brunswick, Fredericton, N.B. E5B 5A3.

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Hence, applications are solicited from individuals who have demonstrated scholarship in research and teaching in any oceanographic subdiscipline. Outstanding applicants suitable for appointment to academic ranks other than professor will also be considered, but preference will be given to applicants suitable for appointment to the higher ranks.

To apply, or for further information, please contact Professor R. O. Reid, Head, Department of Oceanography, College Station, TX 77843 (713) 845-7211.

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Exploration Geophysicist/University of Oklahoma. The School of Geology and Geophysics at the University of Oklahoma will hire an experienced exploration geophysicist to fill the Frank and Betty Schultz Professorship, and is seeking nominations and applications for the position. The person must be a distinguished scientist who has made important contributions to exploration geophysics through research. Preference will be given to a scientist whose specialty is seismic properties of earth materials and who has earned a Ph.D. The Schultz Professorship provides leadership and guidance in establishing a quality teaching and research exploration geophysics group. The University of Oklahoma has recently made a strong commitment to the earth sciences with the establishment of a College of Geosciences, to be housed in a new building. The School of Geology and Geophysics will expand from its present faculty of 18 to 26 faculty members by 1986. This will include three scientists in the exploration geophysics area, five in structure-tectonics-solid earth geophysics and others in stratigraphy-paleontology, geochemistry, petrology, and energy resources.

Applications are due April 30, 1981. Inquiries, nominations, and applications should be sent to John Wickham, Director, School of Geology and Geophysics, University of Oklahoma, Norman, OK 73019.

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Faculty Position in Oceanography/Geology/University of Northern Colorado. The Department of Earth Sciences invites applications for a full-time, tenure track faculty position in oceanography, starting September 1981. We are seeking a person with a broad background in oceanography and one or more of the related earth science fields such as marine geology and/or sedimentology. Major responsibility will be teaching beginning and advanced courses in oceanography, courses in the related field, and general education courses. A modest amount of research is possible and is encouraged. Applicants should possess the Ph.D. degree or be in the final stages of completion of that degree. Starting rank and salary will depend on experience and other qualifications of the candidate selected.

Applicants should submit a resume and at least three letters of recommendation to Dr. L. Glen Cobb, Chairman, Department of Earth Sciences, University of Northern Colorado, Greeley, CO 80639.

The deadline for application is May 10.

Hydrogeologist. Applications invited for a permanent position. The position requires a Ph.D. teaching at graduate and undergraduate levels, supervision of research, and research in area of specialty. Interaction with faculty in surface water hydrology, stable isotopes geochemistry, geophysics, and sedimentary geochemistry is expected. Candidates should send resume, statement of research interest, and addresses of three references to L. D. McGinnis, Chairman, Department of Geology, Northern Illinois University, DeKalb, IL 60115.

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Atmospheric Scientist/Radiation Physicist. Current Applied Research and Systems activities have created immediate openings in the following areas:

1. Spectroscopy, Radiative Transfer and Atmospheric Sciences (1 Position). Requires to work on the general circulation modeling of stratosphere.
2. Atmospheric Fluid Dynamics (1 Position). Requires to develop global atmospheric dynamics problem in the thermosphere.

These positions are in support of science and application tasks of NASA/Goddard Space Flight Center, Greenbelt, Maryland and require one to work on-site.

An extensive background in the numerical simulation of physical problems by use of mini and large computers is required. Candidates must have M.S. or Ph.D. in atmospheric sciences or physical sciences. Both of these positions are renewable up to two years.

Salary range is \$21,000 to \$36,000 per annum, depending on qualifications. Good benefits. Qualified applicants should send three references, salary history and requirements to:

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Suite 600
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Head Earth Resources Branch, NASA/Goddard Space Flight Center. GS-1330-1416. \$37,871-\$50,112 per annum, full-time permanent. The Earth Survey Applications Division, Applications Directorate, NASA/Goddard Space Flight Center invites applications for the open position of Head, Earth Resources Branch. The incumbent of this position is responsible for planning, managing, and conducting broad programs in earth resources remote sensing using satellite and ground-based data analysis, emphasizing the development and demonstration of applications of remote sensing of earth resources from earth orbiting satellites. The primary areas of research in the Branch are land use management, vegetation science including agriculture/forestry/rangeland and environmental monitoring utilizing remotely sensed data and advanced technologies. Also, significant effort is dedicated to sensor data evaluation in terms of applications and scientific utility, and to specification of data acquisition and information extraction systems which best meet user scientific and resource management needs. An advanced degree in earth or physical sciences is required with education in the vegetation sciences, land use or environmental monitoring being specifically preferred. Candidates should also have several years of progressively more responsible experience in the conduct, guidance and management of remote sensing research programs and clear evidence of a strong research background indicating senior research scientist stature.

Resumes/17's should be sent to: Dr. Robert C. Price, Assistant Chief Earth Survey Applications Division Code 520 Goddard Space Flight Center Greenbelt, MD 20771. Deadline for applications is April 30, 1981.

University of Hawaii. The Hawaii Institute of Geophysics and the Department of Geology and Geophysics of the University of Hawaii invite application for tenure track positions available July 1, 1981. Applicants with specialties in any of the following fields will be given consideration:

1. Marine geophysics with emphasis in marine gravity and tectonics
2. Marine seismology
3. Marine magnetics

Applicants should have a Ph.D. degree and a

demonstrated ability to conduct and promote marine research. Ability to teach at all levels is required. The position will be a joint one on an 11-month basis between the Hawaii Institute of Geophysics and the Department of Geology and Geophysics. The appointments will be at the rank of assistant professor.

Apply with resume and names of three references to Charles E. Hales, Director, Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii 96822. Closing date is May 15, 1981.

The University of Hawaii is an affirmative action and equal opportunity employer.

Chemical Oceanography/Marine Geochemistry. Anticipated faculty opening at Florida State University. Applicants from all specialties welcome—preference to candidates who enhance existing programs in marine and atmospheric chemistry, sedimentary geochemistry and radiochemistry. Contact: Chairman/Chemical Oceanography Search Committee, Department of Oceanography, The Florida State University, Tallahassee, FL 32306. Telephone 904/644-6700.

Meteorology Studies Program Coordinator. The University of North Dakota anticipates filling an undergraduate degree in Meteorology. Studies beginning the fall semester 1981. This program will be very application oriented, and will include courses in dynamics, synoptics, radar meteorology, cloud physics meteorology, and forecasting among others. This co-sponsored program requires 40 hours for a major, plus twelve hours of calculus and twelve hours of physics. The program is a great degree the research area and facilities in the co-sponsoring departments of aviation and geophysics.

The coordinator's position will include general administrative responsibility for the program on a day to day basis, teaching of courses in synoptics, dynamics, and radar meteorology as well as being the primary student advisor for the program. Additionally, the position offers an excellent opportunity to be involved in research associated with the department of aviation's multi-year, multi-million dollar research contracts. Facilities include a Citation II jet cloud physics aircraft, a Cheyenne turbo-prop research aircraft, a B-18 glider, a 5 cm digital weather radar, and a dedicated computer facility.

For more information, contact A. Ivan Johnson, Woodward-Clyde Consultants, 209 West 7th Avenue, Denver, CO 80204 (telephone: 303/573-7882).

The position is a 12 month non-tenured appointment within the department of aviation beginning 1 July 1981. The position requires a Ph.D. in meteorology and a strong background in teaching. A specialization in radar meteorology is preferred. Salary is commensurate with experience (\$25,000-\$35,000).

The Department has experienced phenomenal growth in academics and research these past years, and encourages applicants to send their resumes by 1 June 1981 to: Dr. Patrick J. Grady, Department of Aviation, Box 8216—University Station, Grand Forks, ND 58202. The University of North Dakota offers an attractive benefits package, retirement plan, and excellent working conditions. UNO is an equal opportunity employer.

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MARINE RESEARCH ASSOCIATE II.

Analyze and interpret vertical acoustic travel time and pressure data. Prepare progress and data reports. Assist in planning experiments, instrument design modifications, instrument preparation, and at-sea deployment and recovery operations. Develop empirical and dynamical models to be evaluated using EPOCS data. Ph.D. in physical oceanography plus experience in computer programming (applications) and FORTRAN. Submit resume by May 31, 1981 to Dr. Mark Wimbush, Watkins Building, Bay Campus.

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Postdoctoral/Research Associate Positions. The Johns Hopkins University, Applied Physics Laboratory. Positions are available for studies of magnetospheric-ionospheric coupling, hydromagnetic waves, and plasma instabilities in the ionosphere and magnetosphere. The selected candidate will participate in the analysis and interpretation of data from spacecraft and ground-based data as well as in the development and implementation of new ground-based and spacecraft studies. Positions are for one year and are renewable. Tenure may begin at any time through September 1, 1981. Applications should be addressed to Mr. Steven F. Sayre, Dept. A01-15, The Johns Hopkins University, Applied Physics Laboratory, Johns Hopkins Road, Laurel, MD 20020.

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MARINE RESEARCH SPECIALIST II.

Perform chemical research on organic pollutants in marine samples. Collection, preparation, and chemical analysis of samples. Candidate must have B.S. or M.S. degree and be familiar with gas chromatographic methods for the analysis of synthetic organic compounds in samples of water, sediment, and organisms. Knowledge of field sampling techniques would be helpful. Submit resume by April 30, 1981 to Dr. James G. Quinn, Graduate School of Oceanography.

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Meetings

Pacific Energy and Minerals

A call for papers has been issued for the Third Circum-Pacific Energy and Mineral Resources Conference, scheduled for August 22-28, 1982, in Honolulu, Hawaii. Theme of the conference is "Resources for the '80's". In addition to the regular conference sessions, pre-conference workshops will be held on August 21-22. A pre-conference symposium on August 20 on Energy Research in the Circum-Pacific Region will be sponsored by the International Union of Geological Sciences. Geologists' field trips and tours to other Hawaiian Islands are slated for the week after the conference.

Abstracts for oral and poster papers should be received by January 1, 1982. Names of the appropriate program chairmen who should receive abstracts can be obtained by writing to Allen Mabry, Vice President for Exploration, ARCO International Oil and Gas Co., 515 South Flower Street, AP-4985, Los Angeles, CA 90071.

To receive complete conference details, reservation forms, and travel information, contact the AAPG Convention Department, P.O. Box 979, Tulsa, OK 74101 (telephone 918/584-2555).

International Groundwater

A symposium entitled "International Groundwater—The Problems and the Solutions," is scheduled for May 13 and 14 in New York City. Organized by the American Society of

Civil Engineers' Groundwater Committee (part of the Irrigation and Drainage Division), the sessions form part of the society's International Convention and Exposition on May 11-15 at the New York Hilton Hotel.

The program will consist of 12 papers and two panel discussions. International groundwater occurrence, development, and problems will be discussed by specialists from the United Nations and Food and Agriculture Organization, as well as from Australia, Egypt, Finland, India, Israel, Pakistan, Saudi Arabia, Thailand, the United States, and West Africa.

For more information, contact A. Ivan Johnson, Woodward-Clyde Consultants, 209 West 7th Avenue, Denver, CO 80204 (telephone: 303/573-7882).

AGU Job Center at Spring Meeting

AGU will initiate a Job Center for the benefit of registrants and prospective employers at the Spring Meeting in Baltimore. The purpose of this center is to facilitate scheduling of interviews between registrants seeking employment and employers seeking qualified personnel to fill their job vacancies. Job descriptions of open positions will be posted on bulletin boards at the center. Employers planning to attend the meeting should bring job descriptions for posting to the registration desk and fill out a form indicating when someone will be available for interviewing.

Job candidates should bring resumes with them to the meeting. Resumes will be held confidentially but will be open for review by registered prospective employers. Job candidates can review the posted positions and sign up at the Job Center desk.

Interviewing will take place from 9 am to 4 pm Tuesday through Thursday in Exhibit Hall A. Applications and job descriptions can be left at the Job Center in the Baltimore Convention Center from 8 to 4 from Monday on.

AGU Midwest Meeting

September 17-18
Minneapolis, Minnesota

Abstract Deadline: July 1
Convenor: V. Rama Murthy

Papers and posters originating in or pertaining to the region are solicited for the following special sessions:

- Mantle structure and dynamics. Contact Geoffrey Davies or Clem Chase.
- Rock water interactions: Hydrothermal processes and metallogenesis. Contact William Seyfried.
- Precambrian crustal evolution of the North American continent. Contact Paul Weilb.
- Geomagnetism and paleomagnetism. Contact Subir Banerjee.
- Hydrology in the mid-continent U.S. Contact H. O. Plankh or E. C. Alexander, Jr.

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Purdue University. A tenure track appointment in the area of surveying and mapping. Undergraduate teaching in the areas of basic surveying, adjustment computations, and introductory photogrammetry/remote sensing. Involvement in teaching graduate level courses, and in planning and new research programs.

Preference will be given to candidates with a Ph.D. and land surveying registration (or in the process of getting such degree and registration). Rank and salary are open and depend on the experience and qualifications of the applicant.

Send resumes, by 15 April 1981, to: Head, School of Civil Engineering, Purdue University, West Lafayette, IN 47907.

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Penrose Conference on Antarctica

A Penrose Conference scheduled for April 11-16, 1982, will focus on the global significance of the Antarctic plate. Sponsored by the Geological Society of America, the conference will be held in Shenandoah National Park, Virginia. Antarctica is central to several problems of global geologic significance, including the processes of continental fragmentation, as exemplified by Gondwanaland breakup; the nature and development of the present Antarctic plate; the plate's configuration and interaction with adjacent plates during the late Mesozoic and Cenozoic; and the development of Southern Ocean circulation and paleoclimatic change. The purpose of the conference is to bring together scientists from many disciplines to address these problems. Registration fee for the conference: approximately \$350 per person. Special travel arrangements will be made from Washington, D.C. Attendance at the conference is limited to 70.

For an application or additional information, contact either of the convenors: Ian W. D. Dalziel, Lamont-Doherty Geological Observatory, Columbia University, Palisades, NY 10964, or David H. Elliot, Institute of Polar Studies, The Ohio State University, Columbus, OH 43210. Application deadline is November 1.

Rock Mechanics Symposium

The Massachusetts Institute of Technology will sponsor the 22nd United States Symposium on Rock Mechanics, June 29-July 2. Designed for geophysicists, civil and petroleum engineers, and rock physicists, the conference will include papers and discussions on energy, mineral extraction, civil construction, and waste disposal.

Among the topics to be discussed are heat and fluid flow, fragmentation and fracture propagation, deformation of rock masses, and site characterization.

Field trips will be conducted through Boston's Red Line subway extension tunnel as well as through the Seabrook Nuclear Power Station cooling water tunnel.

For additional information, contact the seminar office at 617/253-7481, or write to Barbara Dulles, Coordinator, Center for Advanced Engineering Study Seminars, MIT, Cambridge, MA 02139.

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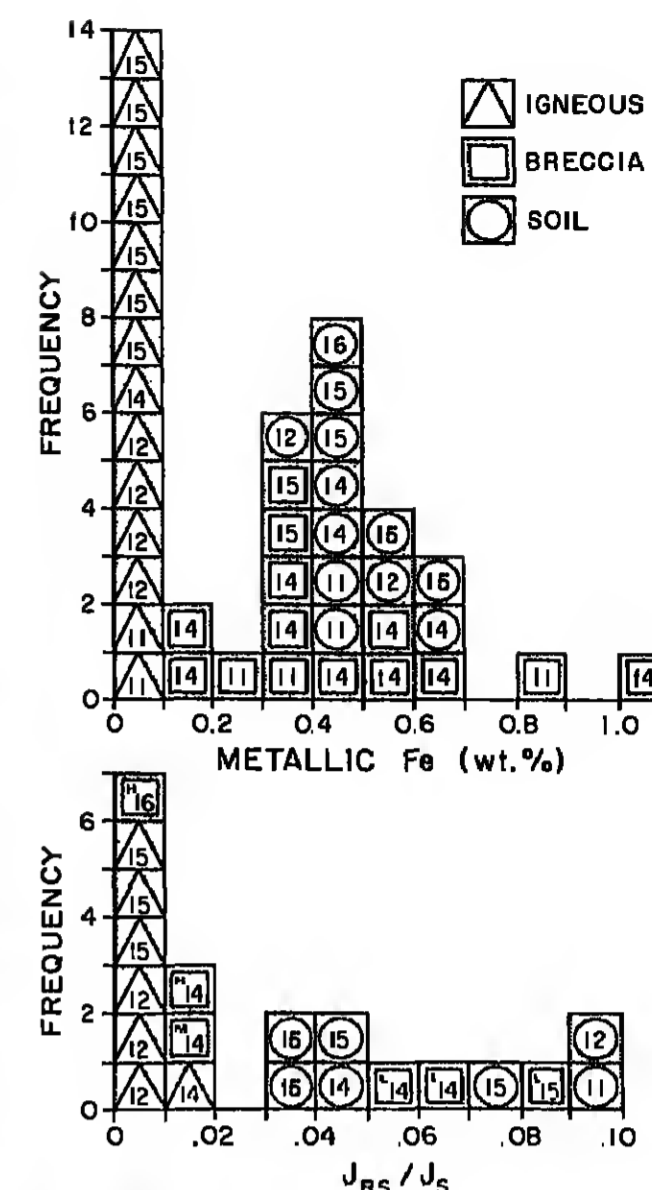
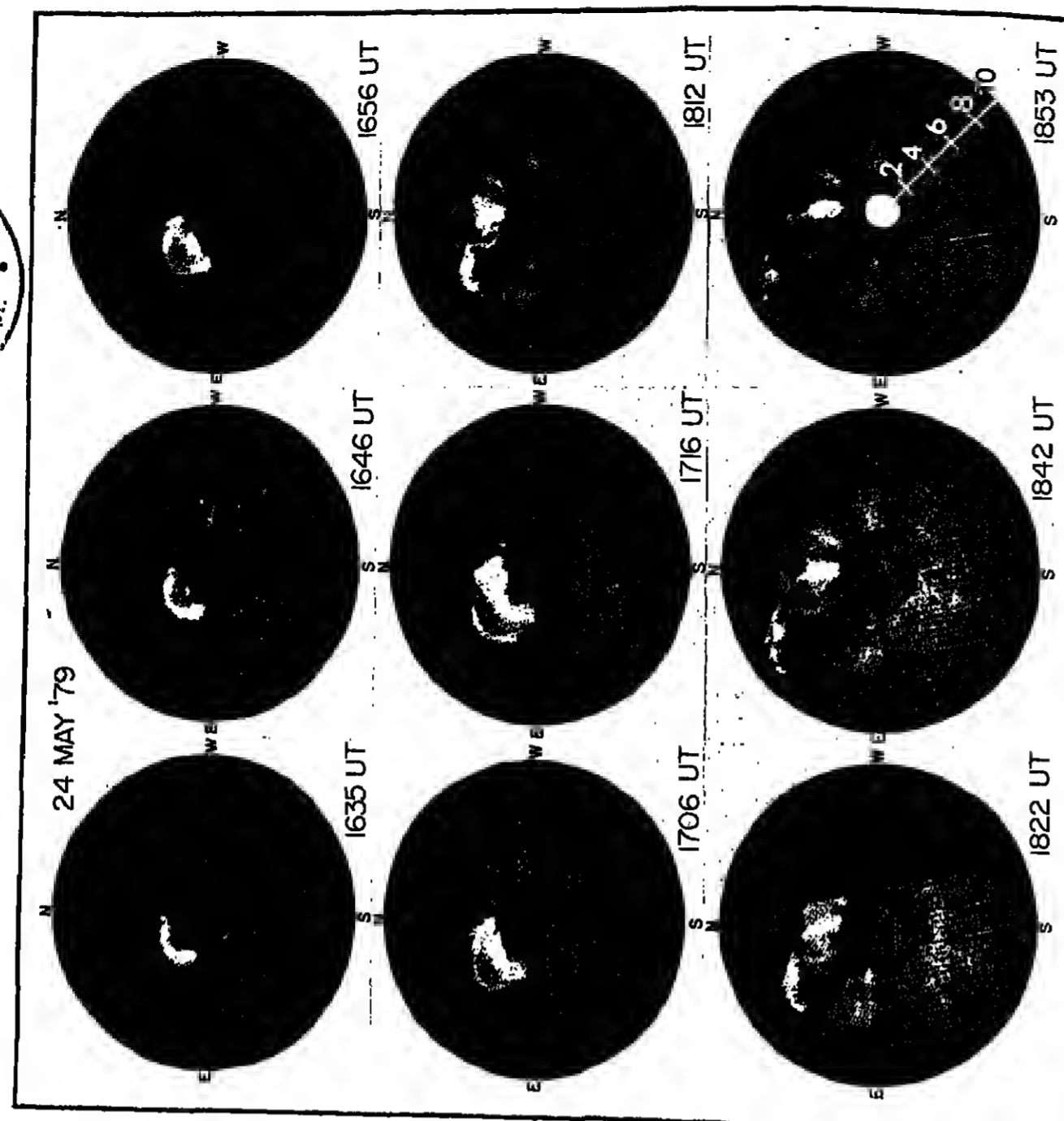
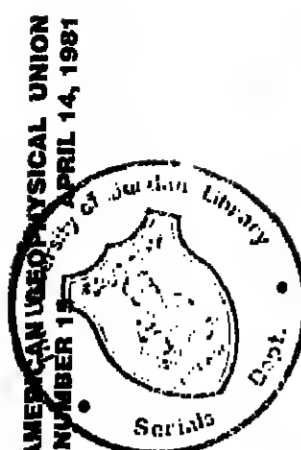


Fig. 1. (Top) Number of examined samples with metallic iron concentrations in specified ranges. The Apollo site number is indicated for each sample. (Bottom) Same for ratio of saturation remanent magnetization to saturation magnetization. [After Strangway et al., 1973a]

The Enigma of Lunar Magnetism

L. L. Hood

Lunar and Planetary Laboratory
The University of Arizona

Introduction

The results of the Apollo program have given us an intriguing but very inadequate glimpse of the pervasive magnetization that characterizes the lunar crust. Returned sample studies, surface magnetic field investigations, and analyses of orbital measurements have provided useful constraints on the nature of the magnetization, but in retrospect, more questions have been raised than have been answered. Perhaps the single most important of these questions concerns the origin of the magnetizing field. A simple possibility suggested from the outset is that the moon once possessed an intrinsic global magnetic field which originated in a small, formerly molten iron core. The existence of such a field, if verified, would have extreme implications for our understanding of lunar, and hence planetary, thermal evolution. However, clear evidence for more than a superficially magnetized crust has not emerged from the data analysis. Thermomagnetic magnetization itself has been difficult to identify unambiguously in samples of the lunar regolith, partly because of their complicated impact histories. Surface and orbital measurements show magnetic anomaly signatures apparently associated with surficial material, such as basin ejecta, and not with deep-seated structures as expected from slow cooling in the presence of a steady magnetic field. Alternative suggestions for the origin of the magnetizing field have primarily involved local generation mechanisms. Of these, those that employ impact processes to briefly but strongly amplify the weak interplanetary magnetic field seem most reasonable in view of (1) the obvious bombardment history of the moon and (2) the association of some mapped anomalies with basin ejecta. In particular, impacts of cometary bodies, which normally possess large partially ionized atmospheres capable of strongly compressing a weak ambient magnetic field, have been mentioned most in this context.

The purpose of this contribution is to briefly assess our current understanding of the nature of lunar crustal magnetization, with emphasis on properties that may provide basic clues to its origin. Brief discussions of returned sample studies and surface magnetic field investigations are provided (for general reviews, see Fuller [1974] and Dyel et al. [1974] respectively), but emphasis is placed on orbital studies that have not been completely reviewed elsewhere.

Returned Sample Data

As deduced from a variety of magnetic property experiments, the main magnetization carrier in lunar rocks is metallic iron alloyed sometimes with small percentages of nickel and cobalt [e.g., Nagata et al., 1972]. As shown in Figure 1 (upper half), among the returned samples the breccias and soils are significantly more enriched in metallic iron than are igneous materials such as mare basalts [Hosley et al., 1970; Strangway et al., 1973a]. Moreover, as indicated in Figure 1 (lower half), iron grains within the breccias and soils are often in the single-domain size range and therefore retain a much stronger magnetic remanence than the multidomain iron in the basalts. Consistent with these properties, the highest levels of stable natural remanent magnetization (NRM), about 10^{-4} G-cm³/g, were reported for some classes of breccias and soils, while the mare basalts were characterized by levels that typically amounted to 2×10^{-4} G-cm³/g or less. The stronger magnetism of the breccias and soils has been attributed to generation within these materials of metallic iron during impacts. This generation takes place via the reduction of iron oxides and silicates already present. Both impact-associated shock [Ciesowski et al., 1974] and heat [Pessier et al., 1972] have been proposed as possible causal mechanisms.

Uncertainties in our knowledge of the generation of ferromagnetic material in lunar rock during impacts, together with the probably complicated impact histories of returned lunar samples, have made interpretations of the observed NRM, with respect to the origin of the magnetizing field, much more difficult. Colson [1978] considers that the primary NRM of lunar basalt rock is most commonly thermomagnetic magnetization (TRM), acquired at the time of extrusion onto the surface, but that the primary NRM has been subsequently modified, sometimes severely, by impact shock. Fuller et al. [1979] conclude that the observed magnetic properties of certain mare basalts are not consistent with a primary stable remanence of thermal origin and that a majority of the observed NRM is most probably a shock remanent magnetization (SRM) acquired during successive meteoroid impacts. These issues are obviously of central importance in understanding the nature of the magnetization process, and additional efforts to resolve them are underway at several laboratories.

Whether the primary remanence is TRM or SRM, the problem of the origin of the magnetic field(s) in which the magnetization was acquired remains. Attempts to measure the ambient field intensity at the times of formation of lunar samples have been difficult and controversial, partly because of experimental problems, partly because of the aforementioned complicated histories of the samples, and partly because of our incomplete understanding of rock magnetism. Nevertheless, there is some agreement that fields on the lunar surface of as much as one Oersted are required to explain the observed NRM of at least some samples [Fuller, 1978]. Stephenson et al. [1974] consider that the required intensities are consistent with the early proposal by Runcom et al. [1970] (and others) that a former global lunar magnetic field, generated by dynamo action in a once active lunar core, is responsible for the primary NRM but that secondary magnetizations were later acquired by poorly understood mechanisms. The differing NRM properties and petrological estimates obtained for subsamples of a single specimen have led Fuller et al. [1979] to argue that a constant planetary-wide paleofield is unlikely and that transient magnetic fields, possibly generated during impacts [Smke, 1977], would provide a more reasonable explanation for these properties.

Finally, mention should be made of the young (<200 m.y.) old soil breccia 70019 collected at the Apollo 17 landing site specifically for magnetic experiments. This sample exhibits NRM properties similar to those of other, usually much older, soil breccias; moreover, Sugrue et al. [1979] succeeded in performing a Thellier-Thellier paleointensity test on the sample's interstitial glass component, obtaining a value of about 2500 G. Since the likelihood of a global lunar magnetic field in the recent past is negligible, the two possible explanations for this result, noted by the authors, are: (1) the sample was magnetized in a relatively strong local remanent field (fields exceeding 300 G were detected at the Apollo 16 landing site, although no measurements were obtained at the Apollo 17 site; see below); (2) the sample was magnetized in a localized, transient magnetic field, possibly generated during the impact which produced the breccia.

Surface Magnetometer Data

As a first step toward extending the results of sample studies to infer large-scale characteristics of the magnetization, it is instructive to consider the intensities and directional behavior of local magnetic fields observed at the Apollo landing sites [Dyal et al., 1974]. A minimal field strength of 3.4 ± 2.9 nT was detected on the edge of the Imbrium basin plain at the Apollo 15 site, and a field of 36 ± 2 nT was detected at the Apollo 12 site on Mare Cognitum. Fields of 103 ± 5 nT and 43 ± 6 nT were measured at the Apollo 14 site, and 1.1 km in the Fra Mauro region at the Apollo 16 site, where fields ranging in intensity up to 327 ± 7 nT were recorded near the Apollo 16 site in the Descartes highlands. Rapid changes in field intensity and direction were observed along a 7.1-km traverse at the Apollo 16 site.

The small scales of the magnetic fields detected along traverses at the Apollo 14 and 16 landing sites imply localized, near-surface sources. One interpretation of this finding is that an originally uniformly magnetized crust has been shattered and almost randomized by impacts. Alternatively, if some or all impacts caused magnetization of successive layers of ejecta materials, then the observed localization of remanent field sources could be due to superposition of layers with differing directions of magnetization.

The wide range in observed field intensities at different sites implies a strong dependence of the crustal field strength on local geologic setting. The Apollo 14 and 16 sites, where the strongest fields were measured, are respectively dom-

inated by the Fra Mauro and Cayley formations. The Fra Mauro and Cayley units are interpreted by most analysts as primary and/or secondary basin ejecta, with at least the Fra Mauro produced at the time of the Imbrium impact [e.g., Taylor, 1975]. The Apollo 12 and 15 landing sites are located primarily in areas dominated by mare basalts. These results together with the stronger stable remanence exhibited by the breccias and soils in relation to that of igneous samples, such as the mare basalts, led Strangway et al. [1973b] to propose that especially coherently magnetized deposits of Cayleylike ejecta materials are likely to be major sources of large-scale magnetic anomalies that are detectable from lunar orbit.

Orbital Magnetometer and Charged-Particle Data

Orbital studies of lunar magnetism began with the Explorer 35 mission, which established the negligibly low value of the global dipole moment [Sonett et al., 1967; Ness et al., 1967; see also, Russell et al., 1974] and indirectly detected crustal magnetized regions via localized compressions of the interplanetary magnetic field observed downstream from the moon [Barnes et al., 1971; Sonett and Mihalov, 1972]. The initial direct detection of crustal magnetic anomalies with the Apollo 15 subsatellite magnetometer [Coleman et al., 1972] led to an eventual application of both magnetometer and charged-particle data from the Apollo 15 and 16 subsatellites to the more detailed study of the distribution and properties of lunar surface magnetic fields.

Much of the early mapping of the direct subsatellite magnetometer data was restricted to measurements obtained within the relatively undisturbed plasma environment of the geomagnetic tail lobe [Sharp et al., 1973; Russell et al., 1975, 1977]. Later mapping concentrated on intervals when the moon was in the solar wind but the Apollo 16 subsatellite was at a low altitude in the lunar wake [Hood et al., 1979a, b]. The possibility of mapping the distribution of lunar surface magnetic fields via their reflection of energetic electrons was first pointed out by Howe et al. [1974] and has been discussed in further detail by Anderson et al. [1975] and Lin et al. [1976]. Although the technique is indirect, it is complementary to the direct detection method because when the subsatellite was exposed to the solar wind or magnetosheath plasma, intervals are quite suitable for mapping, whereas the magnetometer data from these intervals are not. Finally, a study of compressions of the interplanetary magnetic field that was detected with the subsatellite magnetometers in which the locations of several large-scale magnetized regions were inferred has been reported by Russell and Lichtenstein [1978].

At least partly because of the restricted coverage of early magnetic anomaly maps produced from direct magnetometer measurements, the identification of major anomaly sources from this data set was not swift. One correlation of a quasi-linear surface magnetization feature found in electron reflection data on the near side with a long structural rift, Rima Siralis, was reported by Anderson et al. [1977], and quantitative estimates of the magnetization intensities required to explain the anomaly according to several possible models were made [Smke et al., 1979]. However, no firm con-

Geochemistry

1410 Chemistry of the atmosphere
MEASUREMENTS OF CF_4 , C_2F_6 , AND H_2O IN THE LOWER STRATOSPHERE BETWEEN $3^\circ S$ AND $70^\circ N$ LATITUDE
J. F. Vanders (NASA Ames Research Center, Moffett Field, CA 94035), L. C. Y. Su, R. J. Yoon, C. A. Bolchini, and A. D'Amico
Mixing ratios are presented for CF_4 , C_2F_6 , and H_2O in the lower atmosphere. They are derived from measurements made to samples collected by a high-altitude aircraft during a survey in the Northern Hemisphere to the summer of 1977. The vertical distribution of the mixing ratios of these species show a decrease with increasing altitude with a marked decrease at a given altitude with increasing latitude from $2^\circ S$ to $70^\circ N$ latitude. These results agree with our measurements at similar latitudes in the fall of 1976 and with results of other experiments. The experimental apparatus and procedures are described in greater detail than in previous papers. (Ongoing studies, atmospheric, isotopic, and chemical.)
J. Geophys. Res., Ocean, Paper 100192

1410 Chemistry of the atmosphere
EXPERIMENTAL MEASUREMENTS OF NO , NO_2 , AND O_3 PRODUCTION IN A LABORATORY DISCHARGE ATMOSPHERE
J. G. Levine (NASA Langley Research Center, Hampton, Virginia 23061), Robert A. Ragsdale, Gerald L. Gregory, William E. Newell, and Jack Freeman
Measurements of NO , NO_2 , and O_3 production in a laboratory discharge show that within the uncertainties of the experiments, the rate of production of NO is a function of the discharge current and the rate of production of NO_2 is a function of the discharge current and the rate of production of O_3 is a function of the discharge current and the rate of production of NO . The rate of production of NO is a function of the discharge current and the rate of production of NO_2 is a function of the discharge current and the rate of production of O_3 is a function of the discharge current and the rate of production of NO . The rate of production of NO is a function of the discharge current and the rate of production of NO_2 is a function of the discharge current and the rate of production of O_3 is a function of the discharge current and the rate of production of NO . 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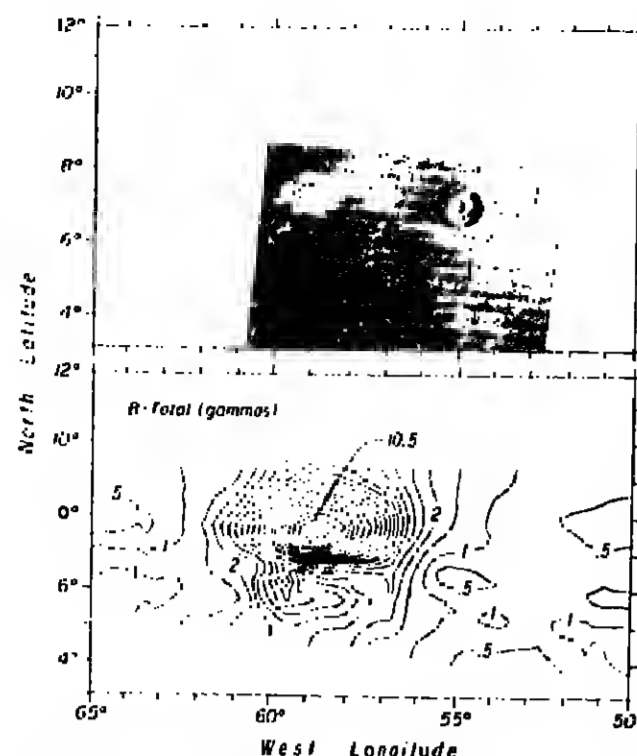


Fig. 2. Correlation of a relatively strong magnetic anomaly found in Apollo 16 subsatellite magnetometer data with a conspicuous medium-albedo marking on western Oceanus Procellarum, known as Reiner Gamma [Hood et al., 1979a].

clusions as to the most probable source of the observed anomaly have been drawn [see also, Anderson and Williams, 1979]. Further insight into the source of large-scale anomalies came when direct Apollo 16 subsatellite magnetometer data that were collected at low altitudes over geologically less complex areas of the near side were examined [Hood et al., 1979a, b]. Magnetic anomalies were found to be nearly absent over the western maria and over several large impact craters such as Copernicus and Kepler; anomalies were, however, detected over exposed segments of the Fra Mauro Formation and over areas dominated by the Cayley Formation. These results represent at least circumstantial evidence that favors Stengwey et al.'s (1973b) ejecta deposit hypothesis, based on returned sample and surface magnetic field data. Further support came from a study of electron reflection maxima detected with the Apollo 16 subsatellite charged-particle instrument across the lunar far side in which the identified magnetized regions occur peripheral to large impact basins in areas where deposits of basin ejecta are observed or inferred [Anderson and Williams, 1979]. This part of the orbital data is consistent with a relatively simple picture in which surficial deposits of ejecta from large meteoroid impacts constitute a major portion of magnetized material on the moon. Such a picture does not immediately allow an identification of the magnetizing field(s), but the possible importance of impact processes in either distorting an existing large-scale magnetic field or in generating short-lived fields of the required intensities is clear.

Less easy to explain via such a simple model are the higher-amplitude anomalies detected with the subsatellite magnetometers and charged-particle instruments. For many years, these anomalies were cited as possible evidence for a former long-term lunar magnetizing field, since it was assumed that rather large thicknesses of crustal material (cooling over long time intervals) must be coherently magnetized to produce anomalies detectable at subsatellite altitudes. Some light was cast on this issue when the strongest anomaly present in data from low-altitude passes of the Apollo 16 subsatellite across the near side was found to correlate exactly with the location of a peculiar swirl-like albedo marking on western Oceanus Procellarum, known as Reiner Gamma (Figure 2). The absence of a detectable gravity anomaly and the superposition of the feature on mare basalt flows, materials that are elsewhere poorly magnetized, increases the probability that the magnetic anomaly is due to a thin surficial layer of strongly magnetized material. If this layer was deposited during an impact, then it may have formed and acquired its magnetization in a relatively short period of time. Thus, although other questions are raised (including the inferred high magnetization level of the source layer), the requirement of a long-term magnetizing field to produce strong crustal magnetic anomalies on the moon may be circumventable. Similar but much more extensive groups of Reiner Gamma-type swirls have been identified on available photographs in highland terrain on the far side (Figure 3). Four of the areas where swirls are most strongly concentrated are known to be nonmagnetically inactive in relation to a large fraction of the lunar surface [Lin et al., 1980]. Most of the areas of especially intense crustal magnetism detected with the Apollo subsatellites can now be associated with general concentrations of swirls, although a one-to-one correspondence has been demonstrated, because of coverage limitations, only for Reiner Gamma.

The geologic origin of the Reiner Gamma-type swirls has been the subject of considerable debate, but the debate has not yet yielded agreed-upon constraints on the more general issue of the nature and origin of lunar crustal magnetization. Hood et al. (1979b) proposed that Reiner Gamma consists of unusually magnetized deposits of ejecta from secondary craters of the nearby large impact crater Cavalerius (age: ~3.2 b.y.). Preservation of the relatively high albedo of Reiner Gamma and some of the other swirls (those that are associated with impact craters older than about 1 b.y.) was ascribed to deflection of the solar wind ion bombardment by the strong magnetic anomaly [Hood and Schubert, 1980]. However, Schultz and Smka (1980) point out that the swirls often contain dark lanes as well as bright palamas, that the bright swirls

are along forward reflectors in contrast with most crater rays, and that at least some of the swirls north of Mare Marghis appear to be associated with the relatively young (late Copernican) crater, Goddard A. Therefore, as an alternative to the crater ejecta hypothesis, these authors proposed that all of the swirls may be along magnetized residues of relatively recent collisions of the moon with one or more cometary comets. While cometary impacts may be viable candidates for providing strong magnetizing fields at the lunar surface [Gold and Soter, 1976], there are several difficulties with the cometary impact proposal for the production of the swirls. These have been noted by Hood (1980). Other suggested mechanisms for producing the swirls, which predate the magnetized data, have been listed by Schultz (1975).

In addition to putting limits on the geologic nature and origin of magnetic anomaly sources, orbital studies using vector magnetometer data have attempted to determine, to a first approximation, directional properties of the magnetization as well. A knowledge of the latter as a function of position in the crust would of course place severe constraints on the orientation(s) and scale-size(s) of the lunar magnetizing field(s). Although source models for a given magnetic anomaly are in many respects nonunique, several assumptions can be made that yield probable estimates for the bulk direction of magnetization of the source. First, based on the several correlations of magnetic anomaly maxima with surface geologic units noted above, it can be assumed that sources are at or

near the lunar surface; a reasonable source model is a uniformly magnetized disk with a finite radius to be determined by a fit to the data. Second, in the case of relatively isolated anomalies it can be initially assumed that the surface position of the source is directly beneath the total field maximum detected from orbit. This assumption is exactly valid only when the direction of magnetization of the source is precisely vertical or horizontal, so in practice, small adjustments from the initial position are necessary in the model-fitting procedure.

The only results reported thus far have been for a section of the lunar far side, in the region occupied by the craters Van de Graaff and Aiken [Hood et al., 1978a, b]. As indicated in the cover figure, it was found that adjacent source regions in the studied area are most probably magnetized in very different directions. The only nonrandom characteristic of the inferred directions of magnetization claimed by Hood et al. (1978a, b) was a depletion in the north-south direction. However, Runcom (1978, 1979) has calculated pole positions of an assumed internal magnetizing dipole that correspond to the inferred magnetization directions. Surprisingly, he finds a small but statistically significant clustering of these pole positions near 0° latitude, 90° and 270° east longitude. Furthermore, he finds that the pole positions that correspond to the strongest anomalies, i.e., those whose magnetization directions were probably determined most accurately, are more strongly clustered than the remainder of the pole positions. Runcom then concludes that the results are most consistent

with the lunar core dynamo hypothesis for the origin of the crustal magnetization, although polar wandering by approximately 90° must be simultaneously invoked.

Since the far-side region considered in the model-fitting analysis was located near 180° longitude, the small clustering of pole positions near 90° and 270° found by Runcom implies that the magnetization directions in the studied area must exhibit a small tendency to be more horizontal than vertical. A reexamination of the inferred directions shows that this is indeed the case as can be seen, in part, from the cover figure. The strong north-south depletion of the inferred magnetization directions, together with their lesser tendency to be more horizontal than vertical, does not necessarily require magnetization by a global magnetic field. Specifically, a compression of the interplanetary magnetic field (which normally lies parallel to the ecliptic plane) against the moon during impacts by bodies with partially ionized gaseous envelopes [Gold and Soter, 1976] could lead to similar directional properties. The highly inclined magnetization vectors required to explain observed anomalies on the far side could be understood by superposition of anomaly sources during successive impacts.

An obvious way to distinguish between these two possibilities is to determine bulk magnetization directions in other areas on the moon, preferably away from 0° and 180° longitude. During the past 2 years, contour maps of the subsatellite magnetometer data in several other regions have been available. Model-fitting procedures are currently being applied to these data.

Suggestions for the Future

The Apollo 15 and 16 particles and fields subsatellite missions were not designed to map the distribution of crustal magnetic anomalies on the moon. Although some excellent data were fortunately acquired within limited regions, optimization of orbital characteristics during a future mission would provide significant increases in coverage and resolution of both direct magnetometer measurements and indirect electron reflection measurements. Essentially, the orbit should be nearly polar with a low-altitude (about 30 km) perisaps near the antisunward position. A polar orbit would provide almost global coverage in contrast to the narrow equatorial bands sampled with the Apollo subsatellites. A 30-km perisaps altitude is required to adequately resolve the crustal magnetic field and is approximately equal to the separation between adjacent polar orbit tracks at the equator (the moon rotates about 1° during a 2-hour orbit). Location of the perisaps near the antisolar position is required to minimize solar-wind-associated plasma disturbances, which strongly affect the magnetometer measurements. Because of the existence of crustal gravity anomalies, which led to the demise of the Apollo 16 subsatellite, and because of the tendency for the perisaps to precess away from the antisunward position, which reduced the usefulness of most of the Apollo 15 subsatellite wake intervals, it is imperative that the spacecraft be capable of modifying its orbit from time to time during the intended mission lifetime.

In combination with additional paleogeologic studies and other geophysical and geochemical measurements obtained from the same spacecraft, such a set of data would place more decisive constraints on the origin of lunar crustal magnetization. For example, if strong magnetic anomalies are associated with other Reiner Gamma-type swirls on the lunar far side that are demonstrably young, then the existence of transient magnetic fields, probably generated during impacts, would be more clearly indicated. Alternatively, if other anomalies are demonstrated to be associated with deep-seated structural features, then the former existence of a global lunar magnetic field would become a more viable hypothesis. It is important to emphasize that more than one process may have been responsible for generating magnetic fields at the moon's surface during its history and only when a complete global survey has been obtained will final conclusions become possible.

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Lonnie L. Hood is a research associate at the Lunar and Planetary Laboratory of the University of Arizona in Tucson. He received his Ph.D. in geophysics and space physics in 1979 from the University of California at Los Angeles, where his research work involved analysis of Apollo subsatellite magnetometer data (under the direction of P. J. Coleman, Jr., and C. T. Russell) and theoretical studies of electromagnetic induction in the moon and Mercury (under the direction of G. Schubert). Current research includes analysis of simultaneous Apollo 12 surface and Explorer 35 orbital magnetometer data (in collaboration with C. P. Sonett and F. Herbert) and studies of problems relating to outer-planetary magnetospheres.

News

Space Transportation

The U.S. space shuttle ushers in a unique flight research program that supports NASA's advanced (21st century) space transportation program.

The space shuttle serves as a "flying test bed," carrying experiments to measure orbital flight performance parameters during launch, booster, orbit, atmospheric reentry, and landing mission phases.

The flight research experiments will aid the development of concepts such as single-stage-to-orbit, heavy-lift launch vehicles and orbital transfer vehicles. These vehicles could develop and service large, automated, human-operated, multifunctional satellite platforms and an inhabited permanent facility in Earth orbit.

Two experiments, called the Orbiter Experiments Program, were included with the flight of space shuttle *Columbia*. The Aerodynamic Coefficient Identification Package (developed by the Johnson Space Center, Houston) on board *Columbia* will collect aerodynamic data during all or major light phases. The Infrared Imager of Shuttle (developed by the Ames Research Center, Mountain View, Calif.) experiment, located aboard a NASA C-141 aircraft, will gather high-resolution temperature maps of the orbiter's thermal protection system during its maximum entry heating phase. The aircraft will underfly the *Columbia* as it returns from space for landing at the mission's end.

The results will advance aerodynamic theories, ground test methods, and other techniques used to predict and simulate performance of aerospace vehicles. The data will also be used to support verification of the current space shuttle orbiter's design and to aid in evolutionary improvements to the space shuttle. [Source: NASA]—PMB

Extractive Metallurgy Program Funded

In an effort to concentrate research on ore dressing and metal production, the National Science Foundation (NSF) formed a new basic research program as a part of its Chemical and Process Engineering Division. This program will be under the auspices of NSF's Engineering Directorate. Research is to be supported on every step of extractive metallurgy, from mining to processing to production, and even to reprocessing and disposal. Budgeting for the new program is expected to be on the order of \$1.2 million for fiscal year 1981.

A program of this nature was apparently considered seriously by the Carter administration as a joint Department of Interior-private industry project of considerable size. Then-Secretary of Interior Cecil Andrus evidently did not support the program, but there is wide agreement throughout the mineral industries and the university community that such research is badly needed for the U.S. to compete. A joint program could benefit by cutting across the many difficult regulations that now are blamed for slowing research in minerals processing in this country.

The newly announced program will probably be conducted as a collaborative effort between universities and industry, but under the NSF. It will be on a smaller scale than that considered by the Carter administration. Director of the funding program, T. Mukherjee, plans a materials science approach. Metal production suffers in the United States by being energy intensive and generally less efficient than in many parts of the world. A strong research effort is needed and fits well in NSF's new Engineering Directorate.—PMB

Dynamics Explorer Twins

Two spacecraft that will ride piggyback into orbit next July are currently undergoing vigorous prelaunch testing at the Goddard Space Flight Center, Greenbelt, Md. Called Dynamics Explorer (DE)-A and -B, the twin satellites are scheduled to be launched together and placed into coplanar polar orbits by a Delta 3913 launch vehicle from the Western Space and Missile Center, Los Angeles, Calif., on July 31.

Their mission will be to explore the boundary region between Earth and space that affects the atmosphere, auroral displays, radio transmissions, and perhaps climate and weather. Solar radiation and the solar wind have a dynamic impact on the near-Earth environment, the results of which affect the state of the atmosphere, ionosphere, magnetosphere, and the more familiar phenomena—weather, auroral displays, and radio disturbances.

Prior spacecraft, such as the Atmospheric Explorers, have provided new information on solar radiation upon the lower atmosphere and upper atmosphere. The ISEE (International Sun-Earth Explorer) program has provided additional new information on interactions between the solar wind and Earth's magnetic field; however, adequate knowledge does not exist on the interactions between the two regions. The Dynamics Explorer program is designed to supply such knowledge—specifically, the strong interaction processes coupling the hot, ionized, convecting plasmas of the magnetosphere and the cooler, denser plasmas and gases circulating in Earth's ionosphere, upper atmosphere, and plasmasphere.

To accomplish this, the project will provide a central data processing and analysis system so that each investigator on the science team can display geophysical data from all spacecraft instruments. In their polar coplanar orbits, one satellite (DE-B) will have a perigee sufficiently low (305 km) for neutral composition, temperature, and wind measurements.

Its apogee will be sufficiently high (1300 km) to provide a

(News cont. on page 164)

(News cont. from pgs 163)

It is more than 1 1/2 years and to allow measurements above the interactive regions for superheated ions and plasma flow measurements of the magnetospheric field lines.

The second spacecraft (DE-A) will be placed into a highly elliptical orbit having an apogee of 24,875 km to allow for global auroral imaging, wave measurements in the middle of the magnetosphere, and crossings of auroral field lines at several Earth radii.

The DE-B (low mission) has six 3-cm-diameter flexible arm antennas 10 m long and a single rigid boom 8 m long. These external antennas will collect data for the scientific instruments on board.

The solar cell arrays mounted on the 136-cm-diameter spacecraft body will supply the satellite with electrical energy that can be delivered directly to the scientific instruments or stored in nickel-cadmium batteries as required.

DE-A is spin stabilized; its pitch, or spin axis having a spin rate of 10 rpm, while the DE-B spacecraft is three-axis stabilized with its pitch axis controlled to continually point toward Earth's surface. Configurations of both spacecraft are designed to minimize unbalancing torques created by atmospheric drag encountered in space.

Tracking, command, real-time, and recorded data will be provided by NASA's Space Tracking and Data Network; the NASA World-Wide Communications System, NASCOM; and the DE Operations Control Center at Goddard. [Source: NASA—PBM]

Antarctic Meteorite Symposium

The Sixth Antarctic Meteorite Symposium was held in Tokyo, Japan, February 19 and 20. Sponsored by the National Institute of Polar Research, the symposium brought Japanese scientists together with several Americans and two Chinese to discuss current research on meteorites, emphasizing research on meteorites collected in Antarctica. The symposium, now an annual event, owes its origin to the recent success of Japanese polar scientists in collecting large numbers of meteorite specimens in the Yamato Mountains, a program now successfully emulated by U.S. parties to the Allan Hills and adjacent regions.

Forty-seven papers were delivered orally, primarily in Japanese (the abstract volume was printed in English), on subjects that included location, field collection, and curation of specimens (8); classification and description of meteorites from Yamato Mountains and Allan Hills (14); mineralogical and petrological studies (8); chemical and isotopic

studies (8); exposure ages and terrestrial ages of Antarctic meteorites (3); magnetic and other physical properties (3); and Chinese meteorites (3).

The contributions represented primarily the work of Japanese scientists (a small part of it in collaboration with workers in the U.S.). The Japanese program is strong in mineralogical-petrological investigations, with a small but growing number of geochemists and geophysicists participating. Despite the mineralogical skills of the Japanese participants, Antarctic meteorite research, basic description of the Japanese collection is not far advanced, in part because of the magnitude of the collection (nearly 4000 specimens) but also because there are few Japanese petrologists who previously have studied meteorites. Efforts are being made to address that problem and to expand the Japanese Antarctic Meteorite Program to international status. As more scientists from outside Japan learn of the collection, the amount of research reported at future Antarctic Meteorite Symposia will certainly grow. Information on the Proceedings of the 6th Antarctic Meteorite Symposium, details of future symposia, and catalogs of the Yamato Meteorite Collection (compiled by K. Yano) can be obtained from T. N. Kato, National Institute of Polar Research, Kaga, Itabashi-ku, Tokyo 173, Japan.—PMB

New Publications

Atmospheric Physics

J. V. Irbarn and H.-R. Cho, D. Reidel, Boston, xii + 208 pp., 1980, \$15.95.

Reviewed by Franklin I. Badgley

This compact book packs a great deal of information into its 212 pages and presents it in a straightforward, comprehensible manner. According to the authors it is intended as a textbook for a university course at a second or third year level for students who have had a first-year general physics course and a knowledge of elementary mathematics. Judging from the content, this must also include a working knowledge of both integral and differential calculus. Some knowledge of chemistry is also essential for understanding the material on that subject.

The text is divided into seven chapters entitled 'General Description,' 'Atmospheric Chemistry,' 'Radiation,' 'Atmospheric Thermodynamics and Vertical Stability,' 'Cloud Physics,' 'Atmospheric Electricity,' and 'Atmospheric Dynamics.' As the authors point out, the sections on chemistry and electricity are somewhat unorthodox but may appear to instructors of certain courses or may be omitted if desired.

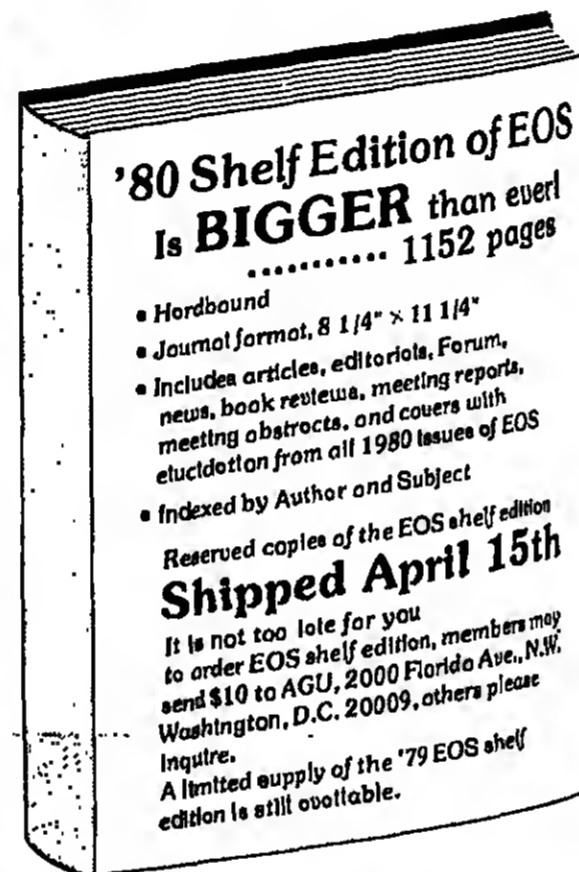
The material is well handled, and certain topics such as radiation and atmospheric electricity are presented as clearly and as concisely as is possible at the level for which they are written. Less satisfactory is the final chapter on atmospheric dynamics which attempts to cover motions of all scales, from global to micro, and from both mathematical and descriptive viewpoints, in 47 pages.

Particularly, in the first part of the book, some important equations are given without derivation; for example, the relationship between electron number concentration and re-

fraction of electromagnetic waves, the Clausius-Clapeyron equation, Planck's law, and related laws concerning black-body radiation. It is probable that the student with the preparation specified above would have encountered these previously so it is a matter of pedagogical preference as to whether to stress the implications of these laws without investigating their source, as the present authors do, or to cover less material with more stress on derivations. In other instances, such as the derivation of expressions for dry and saturated adiabatic lapse rates and of the equations of motion and continuity, the mathematical developments are made concisely, understandably, and with a suitable blend of physical insight and mathematical approximation.

Numerous questions and problems are given at the end of each chapter, some easy, some challenging enough to offer teachers and students a means of enlarging the chapter content. There seem to be few errors. A good bibliography is given. Answers to some of the questions and problems are included. One subject that is not treated but which would fit well with those which are included is atmospheric optics.

It is difficult to know for just what type of audience the book would be exactly suited. It is definitely not for the casual arts or literature student who wants easy access to some knowledge of the atmosphere, nor is this reviewer's estimation is it the best choice as an introduction for a person intending to specialize in the field, although it could be adopted to the latter use. Rather it would most closely meet the requirements of a student well trained in basic science and math who intends to specialize in some field such as engineering, astronomy, or oceanography and who wants more than a cursory insight into the physical nature of the atmosphere, its solved and unsolved problems, and the techniques available for attacking them. Anyone con-



pleting a course for a group of such qualified students should give serious consideration to this carefully written text.

Franklin I. Badgley is with the Department of Atmospheric Sciences, University of Washington, Seattle, Washington.

Exploration Geophysicist/University of Oklahoma. The School of Geology and Geophysics at the University of Oklahoma will hire an experienced exploration geophysicist to fill the Frank Schultz Professorship, and is seeking nominations and applications for the position. The person must be a distinguished scientist who has made important contributions to exploration geophysics through research. Preference will be given to a scientist whose specialty is seismic properties of earth materials and who has earned the Ph.D. The Schultz Professor will provide leadership and guidance in establishing a quality teaching and research exploration geophysics group. The University of Oklahoma has recently made a strong commitment to the earth sciences with the establishment of a College of Geosciences, to be housed in a new building. The School of Geology and Geophysics will expand from its present faculty of 18 to 26 faculty members by 1985. This will include three additional in the exploration geophysics area, five in structural geophysics, and eight in geophysics and geology. The Schultz Professorship is a tenure track position with a salary commensurate with experience and qualifications. Applications are due April 30, 1981. Inquiries, nominations, and applications should be sent to John W. H. Smith, Director, School of Geology and Geophysics, University of Oklahoma, Norman, OK 73019. The University of Oklahoma is an equal opportunity employer.

Associate Professor/New Mexico State University. Geophysics at NMSU is an interdisciplinary program between the Department of Physics and the Department of Earth Sciences with an emphasis in exploration geophysics. We are seeking an additional tenure track faculty member with a background in either seismic and seismology or electrical and electromagnetic methods. The successful candidate will be expected to teach upper division and graduate courses, conduct research and to supervise graduate students' theses and dissertation research in the candidate's area of expertise. The appointee will also be expected to teach freshmen and sophomore level courses in either physics or geology. Minimum qualifications include a Ph.D. degree in geophysics or a closely related area and demonstrated research capabilities. Teaching experience and a proven ability to secure research funding are desirable but not essential. The expected salary range for this position is \$28,000-\$32,000 for the nine-month academic year. Applications and letters from at least three references should be submitted by May 15, 1981 to either: Dr. Russell E. Clemens, Head, Department of Earth Sciences, Box 3A8 or Dr. August Miller, Head, Department of Physics, Box 30, Las Cruces, NM 88003.

New Mexico State University is an affirmative action equal opportunity employer.

Faculty Position/Atmospheric Sciences. The University of Arizona has an opening for a tenure track faculty position in the Department of Atmospheric Sciences. The appointment can be made up to and including the rank of associate professor. Some preference will be given to candidates with specialization in one or more of the following areas: synoptic meteorology, satellite meteorology, boundary layer meteorology, air pollution, and air-sea interactions. The applicant must have an earned doctor's degree in the atmospheric sciences or a related discipline. Applications will be accepted until August 1, 1981. Appointment can be effective as early as January 15, 1982. The candidate must have a dedication to undergraduate and graduate teaching and is expected to develop a high quality research program. Interested individuals should submit a complete curriculum vitae, a list of publications, a statement of teaching and research interests, and three letters of recommendation (not directly by the writers) to Louis J. Battan, Head, Department of Atmospheric Sciences, University of Arizona, Tucson, Arizona 85721. Phone (520) 826-1211. The University of Arizona is an equal opportunity/affirmative action employer.

Texas Tech University Faculty Position. The Department of Geosciences is seeking applications for additional faculty members in geology, geophysics and geochemistry; applicants in all fields of geology other than paleontology will be given serious consideration.

These are tenure track positions of the assistant professor level with appointments starting September 1, 1981. Applicants must have completed their doctoral programs, be interested in teaching at both the undergraduate and graduate levels, and have specific plans for research in their field of specialization. Applicants for the positions should submit resumes, the names of at least three persons from whom the department may request letters of recommendation, and brief description of research interest to:

Donald R. Haragan, Chairman
Department of Geosciences
Texas Tech University
P.O. Box 4109
Lubbock, Texas 79409
Texas Tech University is an equal opportunity/affirmative action employer.

Faculty Position in Oceanography/Geology. The Department of Earth Sciences at the University of Oklahoma is seeking a tenure track faculty position in oceanography, starting September 1981. We are seeking a person with a broad background in oceanography and one or more of the related earth science fields such as marine geology and/or sedimentology. Major responsibility will be teaching courses in the related field, and general education. A model of research in oceanography is encouraged. Applicants should possess the Ph.D. degree or be in the final stages of completion of that degree. Starting rank and salary will depend on experience and other qualifications of the candidate.

Applicants should submit a resume and at least three letters of recommendation to Dr. L. Glen, Head, Department of Earth Sciences, University of Oklahoma, Norman, Oklahoma 73019.

Structural Geologist. The Department of Geophysical Sciences invites applications for a tenure track structural geology position at the assistant or associate professor level, beginning August 1981. Ph.D. required. Salary commensurate with experience and qualifications.

Departmental equipment includes a digitizer, various geophysical equipment, and a remote sensing laboratory with an edgeview enhancer. The candidate will have the opportunity to substantially add to his or her equipment needs. Present computer facilities include a DEC 10 and IBM 360-44, while PK 3240 system with 16 megabyte capacity is under development.

ODU is a state-supported university serving nearly 15,000 students and is situated within the seventh Hampton Roads metropolitan area that is nationally known for its historic, recreational, and cultural facilities.

Send vitae, a brief discussion of research interest, and arrange to have three letters of reference by May 1, 1981 to Dr. Dennis A. Dury, Chairman, Department of Geophysical Sciences, Old Dominion University, Norfolk, VA 23508.

An affirmative action/equal opportunity employer.

University of Hawaii. The Hawaii Institute of Geophysics and the Department of Geology and Geophysics of the University of Hawaii invite application for tenure track positions available July 1, 1981. Applicants with specialties in any of the following fields will be given consideration:

1. Marine geophysics with emphasis in marine gravity and tectonics
2. Marine seismology
3. Marine magnetism

Applicants should have a Ph.D. degree and a demonstrated ability to conduct original research. Ability to teach at all levels is required. The position will be a joint one on an 11-month basis between the Hawaii Institute of Geophysics and the Department of Geology and Geophysics. The appointment will be at the rank of assistant professor.

Apply with resume and names of three references to Charles E. Helsley, Director, Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii 96822. Closing date is May 15, 1981. The University of Hawaii is an affirmative action and equal opportunity employer.

Scientific Coordinator Marine Operations Lamont-Doherty Geological Observatory of Columbia University

The Lamont-Doherty Geological Observatory seeks a marine scientist-manager to coordinate and administer marine operations. Duties include coordination of scientific programs and ships operations, budgetary and fiscal monitoring, personnel assignment, maintaining scientific equipment and providing technical support.

As coordinator, you will direct the operations of a technical support group and marine data reduction and archiving facility. In addition, you will work directly with the Chairman of Marine Geology and Geophysics, but will coordinate the marine programs of all research groups, as well as take the lead in the preparation of proposals to acquire funds in support of facilities.

Qualifications include: 1) experience and/or training in MGS; 2) familiarity with MGS instrumentation and equipment; 3) familiarity with research vessel operations, and 4) management experience.

Applicants should submit resume of educational and work experience to:

Dr. W. J. Ludwig
Acting Chairman
Marine Geology & Geophysics
Lamont-Doherty Geological Observatory
Palisades, New York 10964.

Head, Earth Resources Branch, NASA/Goddard Space Flight Center. GS-1330-1418: \$37,571-\$50,112 per annum, full-time permanent. The Earth Survey Applications Division, Applications Directorate, NASA/Goddard Space Flight Center invites applications for the open position of Head, Earth Resources Branch. The incumbent of this position is responsible for planning, managing, and conducting broad programs in earth resources remote sensing data and applied research and data analysis, emphasizing the development and demonstration of applications of remote sensing of earth resources from earth orbiting satellites. The primary areas of research in the Branch are land use management, vegetation sciences including agriculture/forestry/land and environmental monitoring utilizing remotely sensed data and advanced technologies. Also, significant effort is dedicated to sensor data evaluation in terms of application.

Qualifications and scientific utility, and to application of data acquisition and information extraction systems which best meet user scientific and resource management needs. An advanced degree in earth or physical sciences is required with education in the vegetation sciences, land use or environmental monitoring being specifically preferred. Candidates should also have several years of progressively more responsible experience in the conduct, guidance and management of remote sensing research programs and clear evidence of a strong research background indicating senior research scientist status.

Resumes/8F 17's should be sent to:
Dr. Robert Q. Price, Assistant Chief
Earth Survey Applications Division
Code 820
Goddard Space Flight Center
Greenbelt, MD 20771
Deadline for applications is April 30, 1981.

Ph. D. Scientist I or II

Will work for the High Altitude Observatory in the Solar Variability Section. As part of a group, will develop theories of fluid dynamical and magneto-hydrodynamical turbulence and apply them to problems of solar and stellar convection zones and atmosphere. Examples: turbulent transport of momentum and energy, amplification and dissipation of magnetic fields, turbulent convection. Part of time will be spent developing theoretical parameterizations of turbulent processes which can be incorporated into global models of solar convection and the solar dynamo.

REQUIRES (for level I):

- Ph. D. in Physical Science and strong training in fluid dynamics.
- Demonstrated post-doctoral research experience in turbulence problems, preferably in a geophysical or astrophysical context.
- Research level knowledge of magneto-hydrodynamics and MHD turbulence.
- Willingness to apply turbulence theory to solar and stellar problems.

REQUIRES (for level II):

Substantially more experience beyond the Ph. D. Degree in turbulence problems, preferably in a geophysical or astrophysical context, which has resulted in significant independent research contributions appearing in publications.

Also desired, but not required (for level I and II):
Demonstrated research experience in MHD turbulence problems, as evidenced by research publications.

Salary Range: I — \$23,904 — 35,856
II — \$28,680 — 43,032

This is a three year term appointment which may be occupied 1 October 1981 or later. Send vitae, publication list, and a discussion of relevant scientific background and how you would approach the solar turbulence problem to Margaret Domecki, NATIONAL CENTER FOR ATMOSPHERIC RESEARCH, P.O. Box 3000, Boulder, Colorado 80307. Closing date is August 1, 1981.

NCR

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POSITIONS AVAILABLE

Chemical Oceanography/Marine Geochemistry. Anticipated faculty opening at Florida State University. Applicants from all specialties welcome—preference to candidates who enhance existing programs in marine and atmospheric chemistry, sedimentary geochemistry and radiochemistry. Contact, Chairman/Chemical Oceanography Search Committee, Department of Oceanography,

Geophysicists. Applications are invited for a tenure track position in geophysics for the 1981-82 academic year. The Ph.D. in geophysics or a closely related field is required. We are seeking a candidate capable of teaching undergraduates and graduates courses and supervising graduate research in seismic exploration geophysics. Specific research interests need not be in that area. Applications are encouraged from individuals with industrial experience. Applicants should submit a resume and three letters of recommendation to Dr. David A. Adams, Chairman, Department of Geology, Ohio University, Athens, Ohio 45701. Ohio University is an equal opportunity/affirmative action employer.

Atmospheric Scientist/Radiation Physicist. Current Applied Research and Systems activities have created immediate openings in the following areas:

1. Spectroscopy, Radiative Transfer and Atmospheric Sciences (1 Position). Requires to work on the general circulation modeling of atmospheres.
2. Atmospheric Fluid Dynamics (1 Position). Requires to develop global atmospheric dynamics problem in the troposphere.

These positions are in support of science and application tasks of NASA/Goddard Space Flight Center, Greenbelt, Maryland and require one to work on-site.

An extensive background in the numerical simulation of physical problems by use of mini and large computers is required. Candidates must have M.S. or Ph.D. in atmospheric sciences or physical sciences. Both of these positions are renewable up to two years.
Salary range is \$21,000 to \$35,000 per annum, depending on qualifications. Good Benefits. Qualified applicants should send three references, salary history and requirements to:
Dr. P. S. Asara
Applied Research and Systems
8401 Corporate Drive
Greenbelt, MD 20771

Faculty Opening. The Department of Geological Sciences of the State University of New York at Albany invites applications for a tenure track faculty position which will be available from September 1, 1981 at the assistant professor level for a research oriented scientist to join a department with strengths in structural geology, tectonics, geochemistry and petrology. Applications are invited from geologists, geophysicists and geochemists with Ph.D. degrees who feel qualified to complement or augment studies in these fields. Salary will be negotiable. Letters should be addressed to: Professor Kevin Burke, Chairman, Department of Geological Sciences, c/o Personnel Department, State University of New York at Albany, Albany, N.Y., 12222. SUNY at Albany is an equal opportunity/affirmative action employer. Applications from women, minorities and handicapped are especially welcome.

Hydrogeologist. Applications invited for a permanent faculty position. This position requires a Ph.D., teaching at graduate and undergraduate levels, supervision of research, and research in area of specialty. Interaction with faculty in surface water hydrology, stable-isotope geochemistry, geophysics, and sedimentary geochemistry is expected. Candidates should send resume, statement of research interest, and addresses of three references to: D. McGinnis, Chairman, Department of Geology, Northern Illinois University, DeKalb, IL 60115. An equal opportunity/affirmative action employer.

Purdue University. A tenure track appointment in the area of surveying and mapping. Undergraduate teaching in the area of basic surveying, adjustment computations, and introductory photogrammetry/photo interpretation. Involvement in teaching graduate level courses, and in existing and new research programs.

Preferential consideration to candidates with a Ph.D. and land surveying registration (or in the process of getting such degree and registration); rank and salary are open and depend on the experience and qualifications of the applicant.
Send resumes, by 15 April 1981, to: Dr. L. J. H. Smith, Department of Geology, Purdue University, West Lafayette, IN 47907.

Visiting Assistant Professor. One-year, temporary position available August 1981 to teach mineralogy, general geology, and perhaps optical mineralogy. The successful candidate will be required to teach three courses during a two-semester year; someone who enjoys teaching is needed. Persons on leave are encouraged to apply. Deadline for applications is April 17, 1981. Please send resume to David Kinsley, Department of Geology, Arizona State University, Tempe, AZ 85281. ASU is an equal opportunity employer.

Petrology/Geochemistry, University of New Brunswick. The Department of Geology has a tenure track position available from July 1, 1981, at assistant professor or higher level. The successful applicant will be expected to teach both undergraduate and graduates as well as carrying out research and supervising graduate students. This position is in addition to one currently advertised for a rock mechanic or geochemist.

The applicant should have a background in petrochemistry and petrology and should be prepared to teach in some aspects of petrology and geochemistry. The successful applicant will be responsible for supervision of analytical facilities including an XRF.

Applicants should have a Ph.D. and preferably post doctoral experience. Applications including curriculum vitae and names of three references should be sent to P. F. Williams, Chairman, Department of Geology, University of New Brunswick, Fredericton, N.B. E3B 5A3.

Planetary Geologist. Tenure track assistant professor position starting September 1, 1981, or as soon as possible thereafter to teach and conduct research in planetary geology and geophysics on Earth and other planets. Research should be on understanding the physical processes (for example, impact cratering, volcanism, tectonism) responsible for the origin of planetary surfaces. Applicants must have Ph.D. in planetary geophysics or geology. Deadline for applications: April 30, 1981.

MARINE RESEARCH SPECIALIST II.

Study transition metal and nutrient geochemistry in pore waters of deep sea sediments. Duties include nutrient analysis by electroanalysis and trace metal analysis by atomic absorption spectrophotometry and endogenous geochemistry. Experience in analytical chemistry, internal oceanography and geochemistry desirable.

Submit resume and experience by May 1, 1981 to: Julie Fisher, Graduate School of Oceanography,

UNIVERSITY OF RHODE ISLAND
Kingston, Rhode Island 02881.
An affirmative action/equal opportunity employer.

Postdoctoral Research Associate Position. The Johns Hopkins University, Applied Physics Laboratory, Positions are available for studies of magnetospheric-ionospheric coupling, hydromagnetic waves, and plasma instabilities in the ionosphere and magnetosphere. The selected candidates will participate in the analysis and interpretation of data from spacecraft and ground-based radars as well as in the development and implementation of new ground-based and spacecraft studies. Positions are for one year and are renewable. Tenure may begin at any time through September 1, 1981. Applications should be addressed to Mr. Steven F. Seyer, Opt. ACH-15, The Johns Hopkins University, Applied Physics Laboratory, Johns Hopkins Road, Laurel, MD 20620.

An equal opportunity employer, m/f.

SERVICES

Scripta Remote Sensing Tutorial.
1A. Overview of the Remote Sensing Facility—This one-day seminar describes the data bases, software and processing capabilities available at Scripps Institution of Oceanography, Remote Sensing Facility.

ing Facility. A morning lecture will introduce past, current and future space platforms available for observation of the Oceans. A brief discussion of where and how to access the information will conclude the first part of the class.

The afternoon will include a demonstration of processing and displaying imagery obtained from TIROS-N, NOAA-6 and Nimbus-7.

Classes will be held at the Helen Raitt Room SIO Library on Monday, April 20, 1981 and Tuesday, July 27, 1981, at 8:30 am. A nonrefundable fee of \$50.00 must be submitted with the application. Enrollment limit—12.

2A. User Introduction to the Scripta Remote Sensing Facility—This four-day workshop is intended exclusively for individuals who will be using the facility at Scripps. Two morning lectures will describe in detail the hardware, software and personnel resources available to oceanographers. Existing data bases, their characteristics, location, mode and cost of access will be covered. Status of image processing will be introduced along with in-depth look at the Interactive Digital Image Manipulation System used at the SRSF.

The two lectures will be followed by afternoon lab sessions which consist of hands-on exercises to familiarize users with the hardware/software at the facility. The third morning will be devoted to train use-

era in real-time spacecraft tracking and data recording and acquisition.

The remainder of the 3rd day and the entire 4th day will be used to work with users on a one-to-one basis. Attendees are encouraged to bring their own digital tapes with data of interest to them, which can be used during this last portion of the workshop.

Classes will be held in the Helen Raitt Room SIO Library starting on Tuesday, April 21, 1981 and Tuesday, July 27, 1981 at 8:30 am. A fee of \$350.00 must be submitted with each application. Enrollment limit—6.

For more information regarding applications, fees, etc., please contact University of California at San Diego, SRSF/SIO, Mail Code A-030, La Jolla, California 92093 or (714) 452-2282.

SUPPLIES

Rock Hammer with pick head and leather holster for \$18.00. This is \$6.00 below list price. Write for free catalog "Geologic Field Supplies and Prospecting Equipment". Western Heritage, 101 S. Washington St., Hinsdale, IL 60521. Telephone (812) 984-5228.

AGU

Membership Directory Corrections

Please note the following corrections or omissions from the Membership Directory published in the November 4, 1980 *Eos*.

Benedict P. F. Breje, Jr., Department de Hidraulica—EPUSP, P.O. Box 8174, Sao Paulo, SP, Brazil 05588, (M-78-H).

Robert F. Cockerham, U.S. Geological Survey, Mail Stop 77, 345 Middlefield Road, Menlo Park, California 94025, (M-70-T).

Stephen A. Cooperman, Department of Earth/Space Sciences, University of California at Los Angeles, Los Angeles, California 90024, (O): 213-825-4363, (H): 213-853-8249, (S-79-P).

Irene Fischer, 301 Philadelphia Avenue, Takoma Park, Maryland 20912, (F-56-G).

James T. Peterson, NOAA, RL3-335, 325 Broadway, Boulder, Colorado 80303, (O): 303-497-6866, (H): 303-530-4695, (M-79-M).

William W. Sager, Hawaii Institute of Geophysics, 2525 Correa Road, Honolulu, Hawaii 96822, (O): 808-948-8912, (H): 808-948-7456, (S-79-GP).

Gordon S. Stewart, Seismological Laboratory, California Institute of Technology, Pasadena, California 91125, 230-796-6811, X2958, (ST-75-S).

William Thorderson, 1020 15th Street, 8C, Denver, Colorado 80202, (M-79).

Michael A. Weissman, Flow Research Company, 21414 88th Avenue South, Kent, Washington 98031, 208-872-8500, (M-79-O).

Those members who joined before April 1979 have secondary sections of Seismology and Meteorology withheld.

SAIL INTO
Baltimore
AGU Spring Meeting
May 25-29
Session Highlights

Tectonophysics

Large-Scale Thin-Skin Tectonics (cosponsored by Seismology)

Includes investigations and structural analyses of thin-skin style deformation in regions of both compressional and extensional tectonism. Geologic and seismic evidence for active deformation could be the key to understanding the relationship between ancient analogues will be discussed together with the question of reactivation of décollements. Regional studies span the globe, including investigations in the Himalayas, Aleutian Trench area, big bend area of the San Andreas, Taiwan, Turkey, the Alps, the Apennines, the Appalachians, the Cordilleran fold and thrust belt, and the Basin and Range province. (A full day session on Wednesday followed by a brief business meeting and beer.)

Tectonics of Venus and Earth: A Comparison (cosponsored by Planetology)

Pioneer Venus has provided earth scientists with their first glimpse of the surface of the earth's sister planet. Other data collected by the Pioneer spacecraft on the gravity field of Venus and the composition of its atmosphere provide additional constraints on models of planetary structure and evolution. Analysis of this data clearly indicates that there are significant differences between current styles of global tectonic deformation on these two planetary bodies. This special session will review the fundamental differences between the structure and composition of Venus and the earth. It will also compare our models of tectonic and planetary evolution that have been proposed to account for these differences. Specific topics to be discussed include mantle convection, plate tectonics, continental nucleation and growth, and

Illinois Deep Hole Project (cosponsored by VGP)

Preliminary results of investigations in a privately drilled, continuously cored 1.6-km-deep drill hole in northern Illinois made available to the scientific community. This hole penetrated approximately 1 km of crystalline basement, affording detailed studies of the petrography, chemistry, deformation history, and isotopic geochronology of the Precambrian that comprises the basement, as well as deep measurements of the rock mass permeability, heat flow, and state of stress in this currently tectonically stable interior region. (Monday PM)

Seismology

A day-long special session Wednesday on New Frontiers in Earth Structure is devoted to the seismic transmission problems of anisotropy, scattering, and Q. The topics discussed include mantle anisotropy and its geodynamic implications, apparent and real Q in the short-period passband, and in situ Q measurements. The controversial nature of these studies should stimulate some lively discussions. At the special session on Refraction and Reflection, Tuesday morning, the latest results from COCORP deep crustal soundings will be presented along with theoretical studies of wave propagation in oceanic structure and travel time inversions. A Monday afternoon session on Seismicity and Tectonics will feature a reassessment of the motion between the Caribbean and North American plates, based largely on seismological evidence. Also to be presented at this session is an asperity model for global variations in the modes of subduction. On Tuesday afternoon a session on the Seismic Source will emphasize moment tensor representations of large earthquakes, with a particularly interesting paper on complex earthquakes modeled as two or more large events with different mechanisms separated in space and time.

Volcanology, Geochemistry, Petrology

Arcs and Ophiolites

This session will concentrate on geochemical and isotopic evidence concerning the origin of arc-related volcanism, including the relation between subduction and the chemistry of arc volcanic rocks, and the origin of ophiolites. An important question addressed by several of the papers is that of the possibility that ophiolites represent oceanic crust from more than one geochemical environment. (Monday, A.M.)

Kimberlites and Other Strange Bodies

This section concentrates on the petrology, geochemistry, and origin of kimberlites, but it also includes papers on car-

bonatites, ultramafic bodies, and xenoliths. The session should appeal especially to those who are interested in data and ideas concerning samples from deep-seated environments. (Monday, P.M.)

Precambrian Evolution of the Earth

The two special sessions on the Precambrian Evolution of the Earth will concentrate on the history and processes from the initial accretion to the formation of the continental crust. The origin of the earth will be discussed within the larger context of the origin of the solar system and evidence about formation from the study of meteorites. Subsequent topics to be discussed will include accretions, thermal evolution, convection in the primitive earth, chemical zonation and development, and age and development of continental crust. (Tuesday)

Silicate Melt Structure and Crystallization Processes in Igneous Rocks

A full day will be devoted to these special sessions. They will bring together workers in the fields of crystal chemistry and petrology to present review papers as well as papers discussing new methods and data. Topics will include the structure of geologically important silicate melts, methods of determining melt structure, applications of the concepts of melt structure to petrologic problems, processes of controlled crystal growth from silicate melts, effects of nucleation and growth on the textures and mineral compositions of igneous rocks, and solubility of volatile components in silicate melts. (Wednesday, A.M.)

Seafloor and Ocean Island Volcanic Racks

The source geochemistry and mechanisms of ridge crest midplate volcanism still remain mysterious in spite of a considerable body of data on rocks from these environments. The papers in this session will focus primarily on magma generation process at midocean ridges and geochemical comparison of MORB and volcanic rocks from oceanic islands. Several papers deal with the geochemistry of aseismic ridges and lavas produced from subducted oceanic crust. (Wednesday, A.M.)

Isotope Geochemistry and Geochronology

This session will include a variety of papers of interest to those concerned with new applications and data on isotope geochemistry and isotopic dating. Several papers will concentrate on diffusion of oxygen and strontium. New applications and interpretation of Rb-Sr and Ar-Ar-39 dating, new data on U and Pb isotopic variations in single crystals, and further

developments in Re-187/107Bt chronometry will also be topics of discussion. (Wednesday, P.M.)

Volcanoes and Their Rocks

Two half-day sessions are devoted to the description of circum-Pacific and Pacific volcanoes, eruption mechanisms, and the geochemistry of volcanic eruption products from both oceanic and continental environments. Specific topics range from the mechanism of the 1980 eruption of Mt. St. Helens, through descriptions of volcanic centers in Alaska, Guatemala, New Zealand, and Hawaii, to the geochemistry of continental lavas from North America, Africa, and India. Those interested in magma mixing and magma chambers will also find food for thought. (Thursday)

Neat Papers About Plutonic Rocks

The session focuses primarily on the geochemistry and petrology of granites and granitic rocks from the eastern part of North America. Petrologists interested in the origin of tonalites, nepheline syenites, and gabbros, however, will not be disappointed. (Friday, A.M.)

VGP Potpourri

Among the diverse subjects covered in this session will be new evidence from New Mexico on the Iridium anomaly at the Cretaceous-Tertiary boundary and the extinction of dinosaurs. Also included are a series of papers dealing with the problems of storing nuclear waste in the geologic environment and a paper discussing Nd and Sr isotopic evolution on the origin of central American volcanoes. (Friday, A.M.)

Decade of North American Geology

During the 1980's, as a part of its centennial, the Geological Society of America is sponsoring the Decade of North American Geology. One of the principal goals at this project is the creation of a massive synthesis of the geology and geophysics of the North American Plate. This will be accomplished by means of a series of 15,000,000 geologic, tectonic, gravity anomaly, magnetic anomaly, and lineament maps, and approximately 33 volumes of integrated information on regional geology and geophysics. The activity will involve most major geological organizations on the continent, and products will appear throughout the decade.

A workshop devoted to discussion of plans for the volumes on the Atlantic Coastal Plain and Shelf, the Western Atlantic Ocean Basin, and the Eastern Pacific Ocean Basin is scheduled for Monday, 4-5 P.M., Room 3116.

GAP

Electromagnetics

617 Tectonophysics propagation ANALYSIS OF LONG-TERM STATISTICAL VARIATIONS IN RAIN DEPOLARIZATION. A. A. Kuvshinov, Department of Electrical Engineering, Technical University of Athens, 42, October 28th Ave., Athens 107, Greece. Observed electromagnetic wave depolarization is forward propagation due to precipitation in a short-term period tends to distribute statistically about a mean level of depolarization. Using a special technique of depolarization, we have analyzed the statistical behavior of the rain-rain depolarization (RPD) of the radar signal and found an approximately 4.34 dB about the mean, rain rate (in dB) of the depolarization, statistical variations.

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Meetings

Ocean Sciences: AGU/ASLO Joint Meeting

A joint meeting of the American Geophysical Union's Oceanography Section and the American Society of Limnology and Oceanography will be held February 16-19, 1982, in San Antonio, Texas. The El Tropicano Hotel is headquarters for the meeting, with additional housing available at the St. Anthony and the Glimmer hotels.

The Call for Papers, soliciting contributed papers from AGU and ASLO members, will be issued later this spring. All abstracts must be submitted according to AGU format and guidelines. The deadline for abstracts will be in November. Information on publication will be included in the call for papers.

Special Sessions

Ocean Climate and Biological Productivity Connections
Overview of Large Oceanographic Projects
Biology and Physics of Gulf Stream Rings
Relations Between Biology and Circulation in the Gulf of Mexico

Geological Effects of Ocean Circulation
Anthropogenic Impacts to the Ocean: Diverse Points of View

Processes and Resources of the North Pacific Shelves
Small Lake Limnology
Marine and Freshwater Bioturbation
Ocean-River Interaction: Sedimentation and Chemistry
Particle Fluxes in the Water Column and Benthic Boundary Layer

Relations between Mesoscale Physical and Biological Processes

Coastal Processes
Biological and Physical Measurement Techniques
Microscale Processes and Effects on Biota
Physics and Biology of Ice Edges

Program Committee

Convenors: Worth D. Nowlin, Jr., Department of Oceanography, Texas A&M University, College Station, TX 77843, (713) 845-2947; Richard W. Eppey, Institute of Marine Resources, A-018, S.I.O., University of California at San Diego, La Jolla, CA 92093, (714) 452-2338 (office), (714) 452-3194 (secretary).

Members: Charles D. Hollister, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, (617) 548-1400; Peter Jermers, Ocean Science and Technology Division, Office of Naval Research, 800 N. Quincy Street, Arlington, VA 22217, (202) 698-4590; Claire Scheibel, Great Lakes Research Division, University of Wisconsin, 2200 Bonnie Street Boulevard, Ann Arbor, MI 48109, (313) 764-2422; and Karl Turkkan, Geology Department, Yale University, Box 2181, Yale Station, New Haven, CT 06520, (203) 436-0377.

Housing

El Tropicano Hotel	St. Anthony Hotel	Glimmer Hotel
Single \$37	Single \$44	Single \$35
Double \$47	Double \$50	Double \$41
	Double/Double \$60	Additional person \$5.00

If you are not an AGU or ASLO member, write Meetings, AGU, 2000 Florida Avenue, N.W., Washington, D.C. 20009 and ask to be placed on Ocean Sciences Joint Meeting mailing list.

Erosion-Sedimentation Processes in Mountainous Terrain

The spectrum of processes influencing erosion and sedimentation is greatly enlarged in mountainous areas as compared to lowlands. Accordingly, much of the knowledge gained from studies on lowlands has limited application in mountainous regions. A symposium to review erosion-sedimentation processes in mountainous terrain is scheduled

for the 1981 Fall Meeting of the American Geophysical Union. The meeting will be held in San Francisco during the week of December 7-11, 1981. Four major areas of interest will be considered: (1) surface erosion processes; (2) mass erosion processes; (3) channel processes; and (4) effects of land use. Papers dealing with individual processes or combinations of processes or modeling of responses will be considered.